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PHOTOGRAPH OF A SMALL TORNADO.

On the evening of May 3, 1922, a small tornado developed a few miles southwest of Northfield and passed over the western part of the city. The funnel lifted as it passed almost directly over St. Olaf college and did little damage there, although it had demolished several farm buildings before reaching the college. Two of the students of St. Olaf had nerve enough to attempt to photograph the funnel while it was coming apparently straight at them. The more successful photograph, which is reproduced in Plate XXIV, was taken by Martin Agre, who is said to have sought refuge in a basement immediately after taking the photograph. The tornado funnel is shown quite black against a background of clear sky.

We are indebted to the courtesy of the Mohn Printing Company of Northfield, for the use of the engraved block for Plate XXIV and for the following excerpts from "The Northfield Independent" of May 11, 1922.

"The tornado struck the earth about two miles southwest of town, demolishing the barn, chicken house, and other outbuildings on the L. D. Peake farm. The next place struck was the Geo. Fletcher farm, where a new machine shed and the garage were hurled into the creek. At Osten Boe's place, a few hundred feet from the St. Olaf hill, the kitchen addition to the house was torn away and blown across the road. A number of trees were also uprooted.

"The destruction wrought by the tornado in its narrow path across the Peake and Fletcher farms was most complete, equaling that done in the wider swath of the tornado of two years ago, which passed only a mile to the west. The wreckage on the Peake place was scattered over the adjoining creek valley for a quarter of a mile or more, and on the Fletcher place huge trees had been uprooted, lifted out of the ground with tons of earth clinging to the roots, and the limbs and trunks were twisted and broken. . . . .

"The transportation bus, running on the schedule time from Owatonna to St. Paul, was coming up St. Olaf avenue as the storm approached, and the driver, noticing the threatening outlook, stopped the car on North Lincoln street, only to be caught directly in the path of the storm. Had he stopped 150 feet away in either direction he would have escaped the blast . . . . .

"The passage of the tornado was accompanied by a roar resembling

the noise of a dozen aeroplanes as it churned the clouds in its progress."

The funnel dipped after passing over St. Olaf college, destroyed a small barn, overturned the bus above-mentioned and a Ford automobile, then apparently lifted again and did no further damage, after it became merged with a large thunder storm.

THE CENTENARY OF DELAMBRE'S DEATH.

By MAYNARD SHIPLEY.

On August 19th of this year, the great French astronomer, Jean Joseph Delambre, will have been dead a hundred years. What a marvelous century of progress in his chosen science since he closed his eyes in Paris; and how much of that progress due directly or indirectly to his own studies and discoveries!

In his mere lifetime of seventy-three years astronomy traveled far, and Delambre with it. Pupil of the great Lalande, this poor boy of Amiens who worked as tutor to the children of the rich appealed to the master's heart; and it was at Lalande's urgent request that M. D'Assy, Delambre's employer, set him up in a small observatory of his own, and gave him leisure for research in it.

In consequence, 1781 saw the determination of the orbit of Uranus, just discovered by Sir William Herschel (who, by the way, died also in 1822, just six days after Delambre, but eleven years his senior). The next year, 1782, Delambre determined the orbits of the satellites of Jupiter.

These were great achievements; so were his two best known books, "The History of Astronomy" and "Theoretical and Practical Astronomy"; but he is, of course, most often recalled for his contribution to the establishment of the metric system. In 1799 he and Mechain together traveled from Dunkirk to Barcelona, measuring the arc of the meridian; when it is considered that this feat was accomplished in the midst of the French Revolution, it will be seen that it was remarkable not as a scientific triumph alone.

War and revolution never troubled Delambre's scholarly spirit, however. Like Archimedes, but more fortunate in being spared, he celebrated the siege of Paris by the Allies by working serenely in his observatory from eight in the morning till midnight. The six volumes of his "History of Astronomy" testify to his powers of persevering labor.

In spite of the patronage of Lalande, Delambre's rise in the professional ranks was not rapid, considering the greatness of his gifts. However, upon Lalande's death in 1807, the former pupil was elected to fill the teacher's place as Professor of Astronomy in the College

of France. There Delambre continued, not only to lecture, but to write and study also, in the fields both of astronomy and of physics, until death terminated his quiet and devoted life fifteen years later.

There is no evidence that Delambre and Sir William Herschel were personally acquainted, although their achievements and careers presented so many parallels. Herschel's early struggles led him to depend on music, his second love, for his material support, instead of on the crushed life of the private tutor; Delambre was not so happy as to possess a single-hearted and ardent assistant like Caroline Herschel. Neither did he ever succeed in attracting the favor of a ruler (be it Louis XVI, Robespierre or Napoleon), as did Herschel with that half-lunatic king after whom he named his newly discovered *Georgium sidus*, which we now know as Uranus.

But they had doubtless more in common than any two men who died in Europe during that August of a century ago; and if by some chance there *is* any sort of consciousness and recognition after that fatal plunge, what a joyous meeting there must have been between Herschel and Delambre, as the two famous astronomers rushed off side by side for a personal inspection of the solar system!

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THE PRESENT POSITION OF THE ISLAND UNIVERSE THEORY OF THE SPIRAL NEBULAE.

By DEAN B. McLAUGHLIN.

(Continued from page 295).

We are face to face with a mass of contradictions. The theory that the spirals shine by the reflected light of a bright star at the nucleus might seem at first sight to offer a means of escape from the dilemma. But this cannot be the case. The nuclei of the spirals are not single stars. The published photographs do not show them because the exposure has been so timed as to show faint details. But on observing the spirals visually it is seen that there are all gradations from a diffuse condensation with hardly a trace of central brightening to sharp star-like nuclei. The sharp central condensation of the Andromeda nebula is readily seen to be non-stellar, but if reduced ten or twenty times in apparent diameter it would appear quite star-like. Negative conclusions are unsafe, but it should be noted that the reflection theory was not supported by the results of an examination of spirals for polarized light. If the reflecting bodies were meteorites instead of molecules we might still hold to the reflection theory, for the polarized light would not be sufficient in amount to be detected by the instruments employed. But still the source of illumination is lacking in such objects as M 33 where there is no central star,—at least the

nearest thing to one is a star of magnitude 12 in such a decidedly eccentric position that I believe it must be a galactic star projected on the nebula. The brief conclusion is that, on the basis of present knowledge of spectra, the spectra of the spirals cannot be explained by any theory yet advanced, save the island universe theory.

And the novae? If they are not of the same nature as the galactic novae, then *what* are they? As would naturally be expected if the Andromeda nebula is the nearest of the spirals, the new stars discovered in it are much more numerous than in any other nebula. They have averaged about the seventeenth magnitude. The absolute magnitudes of four galactic novae of known distance average — 3. The The distance of the nebula can be computed on the assumption of equal absolute magnitudes for galactic and spiral novae. It is 330,000 light-years. Taking two degrees for the apparent diameter of the nebula we get for its actual diameter 11,500 light-years. This is somewhat small compared with the usual estimate of galactic size, but the Andromeda nebula is very condensed and of high luminosity. According to Jeans' hypothesis it will in time become more diffuse. It will then appear more like M 33 which is the most fragmentary of all the large spirals and intrinsically very faint.

But on the theory that the spirals are small bodies close to our system what explanation is there for the novae? Dr. Harlow Shapley has suggested[29] that the phenomena of novae are due to the engulfment of a star in the nebulosity. He takes the probable distances of the spirals to be of the order of 20,000 light-years.[30] Now in a few cases the dimming of a spiral nova has been observed to occur at about the rate of dimming of a galactic nova. This fading is possible only if the bombardment of the surface of the star by the particles of the nebula ceases. The bombardment can be stopped only if one of two things happens: either the star passes clear through the nebula, or it is brought to a state of rest with respect to the nebula. The first alternative is obviously ruled out when we consider the short duration of a nova and the large value of the least thickness of the spiral nebula. In the case where friction brings the star to rest with respect to the nebula we have a very anomalous phenomenon. Although the nebula which runs down the star is moving at, say, ten times the speed of a galactic star which meets a nebula, yet the energy which is transformed into heat is only a small fraction of that which is similarly transformed in the case of galactic novae. The energy transformed into heat varies directly as the product of the mass by the square of the change of velocity, yet the nova produced is *six magnitudes fainter than the galactic novae*. We can only assume that there are immense swarms of bodies as massive, perhaps, as Jupiter moving through space in the outer regions of the galactic system. We should never, except in desperation, appeal to unknown agencies of this sort. It

[29]Shapley, H., Pub. Astr. Soc. Pacific, Vol. 30, p. 53. 1918.
[30]Ibid., Vol. 31, p. 267 (footnote). 1919.

seems to me that we are far from being desperate in the present case. *The phenomena of these novae admit of but one interpretation in the light of present knowledge. The island universe theory alone gives an adequate explanation.*

The significance of the last two points mentioned in the tabulation of observational data is rather uncertain. The blueness of the spiral arms would seem to indicate that they are composed of early type stars, while the nuclei consist chiefly of stars of later type. The fact that the planes of a number of the larger spirals pass near the sun may indicate some physical relation between the spirals and our galaxy (probably a gravitational effect) but the application of the theory of probability to such small numbers means little.

A calculation of the surface brightness[31] which our galactic system would have if viewed from a distant point in space shows that it would probably be beyond the power of photographic telescopes, provided the star density in the region about the sun be taken as typical of the system. But the Milky Way star clouds are much denser than the solar neighborhood and would be detected by photography from a distance of several millions of light-years just as certainly as they can be photographed from a distance of ten or fifteen thousand light-years. Most of them are real condensations and not effects of perspective. To produce the appearance of these clouds by perspective, assuming the star-density to be no greater than in the solar neighborhood, it would be necessary to have streams of stars bristling outward in all directions from the sun,—obviously a highly improbable state of affairs. It is not necessary to place the sun at the center of the system, or even within the nucleus of the galactic spiral (if such there is). Indeed, the sun must be outside the nucleus if the galaxy is at all similar to the spirals, since the star-density is so low in the regions near it that those regions photographed from a distance would appear vacant.

Dr. C. Easton is the foremost exponent of the spiral theory of the Milky Way. He does not, however, connect it with the island universe theory; at any rate he was opposed to the latter theory[32] in 1913 and I have found no statement of his which would indicate a change of opinion since then. In an early paper[33] on the subject he has shown that the ring or double ring theory will not even approximately explain the appearance of the Milky Way. The spiral theory, on the other hand, would furnish a means of explaining many of the peculiar appearances. One factor in the distribution of the galactic light was not known at that time, viz.: the existence of large tracts of occulting matter which modify the apparent forms of the star clouds to some extent. Even in a more recent paper[34] he does not consider this as of

[31]Seares, F. H., Mt. Wilson Contrib., 191, 1920.
[32]Easton, C., Astrophys. J., Vol. 37, p. 116, 1913.
[33]Ibid., Vol. 12, pp. 136-158, 1900.
[34]Easton, C., Monthly Notices, Vol. 81, pp. 215-226, 1921.

much importance. We shall have occasion to discuss this matter later on.

Anything which affects the ideas of astronomers on the subject of the structure of the stellar universe must likewise affect their ideas on the island universe theory. Dr. Harlow Shapley, in his researches on stellar clusters, has come to the conclusion that the diameter of the system is about ten times what has usually been given as an estimate. It would appear that if this be true the island universe theory has met a great obstacle. If we should give the Andromeda nebula a diameter comparable with Shapley's estimate of galactic size the novae which appear in it would have to be of tremendous brightness,—absolute magnitude — 10, or an even greater negative figure. Very rarely a stupendous catastrophe might produce a nova of this brightness. Tycho's nova of 1572 was probably such a case, and S Andromedae which appeared in the great nebula must have been of absolute magnitude — 14 on the basis of the island universe theory. Such cases are exceptional and should be treated as such. But the general run of novae cannot be reconciled with such distances. As for the new stars appearing in the smaller spirals, they would have to be even brighter.

Briefly stated, Shapley's conclusions are as follows:[35] the entire galactic system proper (i. e. excluding the globular clusters and the spirals) is contained in a discoidal space of diameter 300,000 light-years and thickness about 10,000 light-years. Outside of this system, i. e. above and below the disc, *but not about its periphery,* are located the globular clusters. They form a flat system perhaps 60,000 light-years in thickness including the galactic system proper. Few globular clusters occur within about 6,000 light-years of the galactic plane,[22] and the cluster nearest to the sun is 21,000 light-years distant. The position of the spirals is indeterminate but they are supposed to be about 20,000 light-years away. The sun is 50,000 light-years from the center of the system.

In order to explain the distribution of the clusters and the spirals Shapley advances the hypothesis[36] that the galactic system has been formed by the accumulation and disintegration of globular clusters; any cluster which comes within a given distance of the galactic plane is subject to disruption and becomes at first an open cluster and is finally dispersed. He considers the galactic system as a rather heterogeneous assemblage,—a chaos of star clouds, individual stars, open clusters and nebulae. The spirals, on the other hand, are repelled from the system by radiation pressure or a similar force. Thus the recession of the spirals and the approach of the clusters, as well as the absence of globular clusters from the equatorial region and the accumulation of the spirals in the regions of fewest stars are accounted for.

[35]Shapley, H., Astrophys. Jour., Vol. 49, pp. 311-336. 1919.
[36]Ibid. Vol. 50, pp. 131 ff. 1919.

If the clusters are thus dispersed, only two causes can be responsible if we assume that gravitation is the only ruling force in the motions of the clusters. In the first place, the members of the cluster might have encounters with galactic stars and so be deflected from their orbits; and secondly, the cluster would be subject to the tidal action of the galactic system as a whole. The first case has been analysed by Jeans; I take the statement from Professor Eddington.[37] "Considering a moving cluster, all the stars of which have equal and parallel velocities of 40 km per sec., let a star be considered to continue a member of the main stream so long as its direction of motion does not diverge by more than 2°. *After 100 million years only 1 in 8,000 of the original members will be lost by violent encounters, and the remainder will make angles with the main stream of which the average amount is only 10'.*" In view of the very intense gravitational field within a globular cluster and of the short time required to pass through the equatorial zone (15 million years to cross the space of 10,000 light-years at 200 km per second) I do not believe that either the first or the second cause could produce the dispersal of a globular cluster.

As for the spirals, are we to suppose that radiation pressure will repel such masses as they must have if the measures of the Mt. Wilson plates are reliable? In order to produce the spectrum observed, the gases must be under pressure, which requires the formation of very considerable bodies upon which radiation pressure would have a negligible effect.

As a matter of fact the observed spirals are chiefly in such high galactic latitudes and are so utterly lacking in the region between galactic longitudes 300° and 60° that conclusions that they are all receding, and are repelled by the stars, are premature. Figure 2 shows that nearly all of those spirals, on which Dr. Shapley bases his statement that they are being repelled, are confined to a single hemisphere of the sky. When more south galactic spirals as well as some in the cluster region have been observed, our conclusions will carry more weight. In the meantime we merely note that a determination of the apex of our stellar system with respect to the spirals indicates that the sun and all its neighbors are moving towards Capricornus with a speed of about 600 km per second.[38]

Dr. H. D. Curtis objects to the theory of a larger galaxy on the following grounds:[39]

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[37]Eddington, A. S., Stellar Movements and the Structure of the Universe, p. 253. Macmillan and Co., London, 1914.

[38]Young, R. K. and Harper, W. E., Journal of the Roy. Astr. Soc. of Canada, Vol. 10, p. 134, 1916.

[39]Curtis, H. D., Bull. Nat. Research Council, Vol. 2, Pt. 3, No. 11, pp. 194-216. 1921.

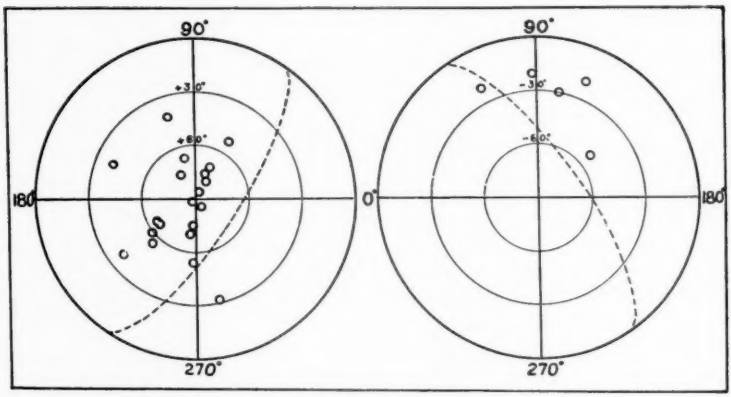

Fig. 2. Distribution of the spirals with observed radial velocities. Those plotted are taken from list in Astrophys. J. Vol. 50, p. 125. Coördinates are galactic longitude and latitude. Dash line is a great circle so drawn as to place all but two of the observed spirals in one hemisphere.

1. The distances of the clusters should be obtained by means of the *average* stars rather than the giant stars of the clusters.

2. There are uncertainties in the luminosity-period relation of Cepheid variables. This relation is one of Shapley's means of determining the distances of the clusters.

3. The larger galaxy is incompatible with the island universe theory. Dr. Curtis is the foremost exponent of the latter theory.

Taking up the first point, we find that in the globular clusters *the color indices of the brightest stars are large positive quantities* while the stars with *smaller positive and with negative color indices are almost invariably much fainter.*[24] This means that the stars of late spectral type are much brighter than those of early spectral type. The situation in the galactic system proper is quite different. The giant stars of all spectral types are of approximately equal brightness, save the early type stars, *and they are the brightest of the giants.* So the relation brought out in Professor Russell's theory of stellar evolution is apparently reversed in the globular clusters. We must either consider the red stars as super-giants, or the blue ones as abnormally faint. Shapley appears to have assumed the blue stars to be similar to galactic blue stars, thus choosing the first alternative. Curtis prefers the latter alternative. It is difficult to decide which is the more justifiable, but it should be noted that a super-giant star would be an abnormally bright body while still red and that it would later develop into a still more brilliant blue star. This point of view, however, involves the assumption that we see in the clusters several cycles of developing giant stars, the later cycles consisting of much larger stars than the earlier. This must remain an open question.

Curtis objects to the employment of the luminosity-period relation in determining the distances both of the clusters and of the Cepheids within the galaxy proper on the grounds that the data used for deriving this relation were insufficient and that the proper motions and random motions of the stars are too uncertain to derive *individual parallaxes* from *individual proper motions*. Shapley used the proper motions of eleven Cepheids.[40] This question, too, must remain an open one.

Considering the subject of this paper it would not be legitimate to discuss the objections to a larger galaxy on the grounds of the island universe theory. As the matter stands now, we have the apparent contradiction of the larger galaxy theory of Shapley and the island universe theory as set forth by Curtis. The all-important question is: can the two theories be reconciled?

Again we must take stock of the results of observation. Without much discussion of the validity of Shapley's conclusions, I shall, for the sake of the argument, accept most of his results for the distances of the globular clusters and galactic Cepheids. The distances of the coarse clusters are less reliable and are admittedly open to some doubt.

Shapley's Results.

Cepheids.[41] The most distant Cepheid is 20,000 light-years from the sun. Only six are at distances greater than 12,000 light-years.

Globular Clusters. The most distant is at 220,000 light-years, the nearest (ω Centauri) at 21,000.[42] None are *found* within about 4,000 light-years of the galactic plane and only a few within 6,000.

Galactic Clouds. The clouds in the region of M 11 are at 15,000 light-years distance.[43] Magnitudes of stars in the clouds indicate that they extend a great distance in the line of sight—as great as the distance of the nearer side of the cloud from the sun.

Open Clusters.[44] Later, M 11 is placed at 23,000 light-years, and 70 clusters are determined to be at various distances up to over 50,000.

The most uncertain part of the work lies in the determination of the distances of the open clusters. Many were determined by means of the apparent diameters. The use of the apparent diameter of a globular cluster may lead to relatively accurate results, but the diameter of an open cluster is such an uncertain quantity that little confidence can be placed in the derived distances. There seems to be no reason why all open clusters should be of even approximately the same size, and even if they are, their apparent diameters are highly uncertain. If the open clusters are really in the midst of the galactic clouds, as many of them appear to be, then the distances of these clouds do con-

[40] Shapley, H., Astrophys. J., Vol. 48, pp. 89-124. 1918.
[41] Ibid., pp. 279-294. 1918.
[42] Ibid., Vol. 48, pp. 154-181. 1918, and Vol. 49, p. 250. 1919.
[43] Ibid., Vol. 46, pp. 64-75. 1917.
[44] Shapley, H., Proceedings Nat. Acad. of Sciences, Vol. 5, pp. 344-351. 1919.

flict with the island universe theory. We should hardly expect to see the clusters *through* the clouds, although there may be a few cases of this sort. As for the great extension of the clouds in the line of sight, we cannot suppose that it is much greater than the apparent diameters of the clouds, since it is altogether out of the question to consider the stars as being arranged in streams directed away from the sun.

Easton objects to the larger galaxy theory[34] on the grounds that there is a concentration of stars as bright as magnitude 8.5 and 9.0 in the galactic clouds, and that a similar concentration of stars of large proper motion is found. An examination of his tables, however, will cast some doubt on these conclusions, especially in view of the existence of occulting matter. In 10 cases out of 17, there is an agreement of observation with theory, 2 cases are neutral, and 5 contradict theory. This is not a sufficient agreement. Moreover, the region which shows the best agreement is the one in which the most occulting matter occurs, as Easton himself states. It is quite probable that some, at least, but by no means the majority, of the Milky Way star clouds are delimited by dark material. This would influence all star-counts for comparison of dark and bright areas of the Milky Way. When huge masses of obscuring matter exist as close to us as Rho Ophiuchi and B. D. —10°4713 we can readily see that they would greatly influence the apparent distribution of the Durchmusterung stars. The great cloud of dark nebulosity about the latter named star determines the western border of the great star cloud about M 11.

There is a distinct concentration of the stars of magnitude 12 and fainter in the star clouds, and for this reason I believe that most of these aggregations are within 15,000 light-years and that the upper limit of distance may be placed at 20,000. The star clouds themselves cannot be an effect of perspective, although the faint galactic light outside the clouds may be largely due to this cause.

All the evidence indicates that the Monoceros region of the Milky Way is closer to the sun than the opposite portion. The degree of condensation of the star clouds, the range of open clusters and planetary nebulae from the galactic plane all indicate this. Tracing the Milky Way from Monoceros through Auriga, Cepheus, Cygnus, Aquila, and Sagittarius, we find that in general its gradual trend is towards greater local condensation into star clouds. This corresponds to the tracing of the arms of a spiral from the nucleus outward. If, then, the Milky Way is a spiral it would be natural to think of it as a right-handed one when viewed from the north galactic pole.

The intrinsic brightness of the Milky Way spiral is very low; M 33 observed visually is the best comparison I know of. In the type of spiral represented by M 33 the arms are extremely fragmentary, and no definite limits can be assigned to the nebula. The nucleus is not very bright, nor is there much central brightening in it. It appears

that the galactic system, if it is a spiral, is of the M 33 type, although that nebula is somewhat more fragmentary than the Milky Way.

The apex of the galactic system with respect to the spirals lies in the constellation Capricornus. This motion might be partly due to rotation within the system in such a direction as to carry the sun and all its neighbors towards that region, or rather towards some point in the galactic plane near that region. We recall that the clusters as a class are *approaching*, while the spirals are generally *receding*. The great mass of clusters is located in the very portion of the sky towards which a rotation of the system might be carrying the sun, while most of the spirals are far from that part of the heavens. Thus, the apparent approach of the clusters may be due to a rotation within the system, while the apparent recession of the spirals may be the combined effect of this rotation and a motion of the entire system, the globular clusters participating in this motion.

It has been stated that the theory of a larger galaxy contradicts the island universe theory, that is, *as these two theories are usually interpreted*. In the tabulation of observational data on the spirals I mentioned that many small nebulae (517 in number) are found in an area 8° in diameter about M 33, and they appear to lie in the prolongations of the spiral arms. *Might not this be the relation that exists between the globular clusters and the galactic system proper?* It may be objected that the globular clusters show no evidence of such a relation, as they do not occur in long chains, nor are they confined to the galactic plane as would be expected on this assumption. Let it be remembered that the galactic system, according to Jeans' hypothesis, is an old system; it has been subjected to great disturbances if it has recently passed through the great cloud of spirals, as its recession from them would indicate. In addition, the two Magellanic clouds may be nearby spirals; they are receding and it is possible that in not very remote geologic time they passed so close to the Aquila arm of the galactic spiral as to draw it from the general plane of the system. They would also have caused great disturbance in the cluster region, scattering the clusters from the galactic plane, and they must be acting almost as strongly on the globular clusters at the present time. I lay no great stress on such conjectures as these, but they indicate in a general way what could have happened. The scattering of the globular clusters from the galactic plane may, indeed, be due solely to the Magellanic clouds.

The globular clusters, according to this view, are not really absent from the galactic equatorial regions, but those which are there are hidden by the occulting matter *on the outer edge of the spiral arm* Therefore, we need not look for large masses of dark nebulosity in every region "avoided" by the clusters, since there is no stellar background to render it visible. A striking example of this obscuration is seen in the relation of globular clusters to the greater star cloud of

Sagittarius. Fig. 3 shows all the N. G. C. clusters about the cloud, and although they occur all around it, none are found in the denser portions. I consider the obscuration to be due chiefly to dark matter on the far side of the cloud, that is, on the outer side of the spiral arm. There is no doubt that the clusters are at much greater distances

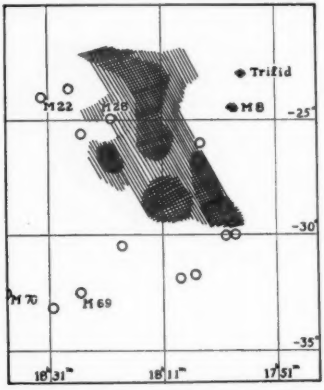

Fig. 3. Globular clusters about the greater Sagittarius star cloud. Note total absence of clusters from dense regions, although they are found on all sides of the cloud. The cloud was drawn in from a photograph reproduced in Fig. 6. Positions of two irregular nebulae are indicated.

than the great cloud. Several globular clusters are seen through the diffuse clouds of Scorpius and Ophiuchus, and there must be many in that region which are concealed by the large tracts of dark nebulosity. Thus, the clusters are not really broken up when they near the galactic plane. The coarse ones belong to the inner spiral, and so are not concealed from view, but the globular ones are beyond the Milky Way spiral and many of them are hidden. Some of the coarse clusters may also lie far beyond the arms of the spiral and in the region of the globular clusters.

I am rather hesitant about presenting a diagram of the general plan of the galaxy because the probabilities against its being even an approximation are very great. Fig. 4 is given, not as an attempt to fix the actual relations between particular parts of the system, but to indicate only the general relations between *entire classes of parts*. I have endeavored to reconcile the motion of the sun towards a point in the constellation Capricornus with an outward motion along the spiral arms, in accordance with Jeans' hypothesis, but the position of the nucleus is a weak point in the construction. Is it necessary, however, that the motion be outward along the arms? Might we not expect it to be transverse to the arms at some points? These questions will indicate that we know too little of the motions within the spirals to attempt to fix the particular parts of the system. Easton has chosen

the region of Cygnus, which makes an excellent nucleus, so far as appearances are concerned, and indeed, if the Milky Way is a spiral the Cygnus condensation may be the center of the galaxy, but in that event the motion within the system would have to be other than outward along the arms.

The sun is placed well outside of the nucleus because the star-density about it is very low,—too low for a part of the nucleus. The

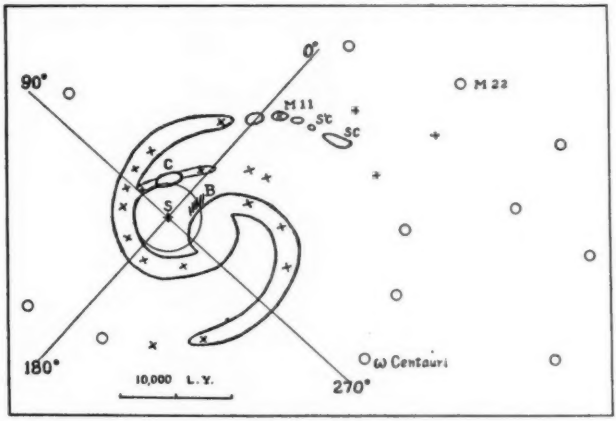

Fig. 4. Galactic spiral and outlying globular clusters. Crosses represent coarse clusters; circles, globular clusters. S, sun; SC and S′ C′, Sagittarius star clouds; C, Cygnus cloud; B, Barnard's dark nebulae in Ophiuchus. Axes indicate quadrants of galactic longitude. Circle of 3000 L. Y. radius indicates distance at which a star of 0 absolute magnitude would be of apparent magnitude 9.5 (the limit of the Durchmusterung).

sun is supposed to be within a very sparse cluster (the local cluster mentioned by Shapley) occupying the region between the central condensation and an arm of the spiral.

I cannot emphasize too much the very arbitrary character of this construction. *The essential point in the hypothesis here proposed is the relation between the globular clusters and the galactic system proper.* The star clouds are all within the small radius of 20,000 light-years, while the globular clusters may be at the distances derived by Shapley. There may be a great group of clusters on the other side of the system, but it has not been disturbed, so most of its members are hidden by the Milky Way. The distances which Shapley gives are an upper limit. Whatever reduction may ultimately be made will not affect the island universe theory. With the galactic spiral proper limited to a diameter of from 30,000 to 40,000 light-years and the globular clusters at the great distances of 200,000 light-years or more the island universe theory is still tenable. In M 33 let the radius of the cluster system (4°) correspond to 250,000 light-years, then the ra-

dius of the spiral is approximately 15,000, that is, it is comparable with our galaxy. On this basis its distance would be 3,500,000 light-years.

So far the nature of the relationship between the globular clusters and the galactic system proper has been inferred by analogy from a single case. Now if the Magellanic clouds are truly spiral island universes, and this "outlying cluster hypothesis" be true, the globular clusters about the clouds should show this hypothetical relationship to them. There are only a few globular clusters about the lesser cloud, but there are 15 about the greater. Fig. 5 shows all the N. G. C.

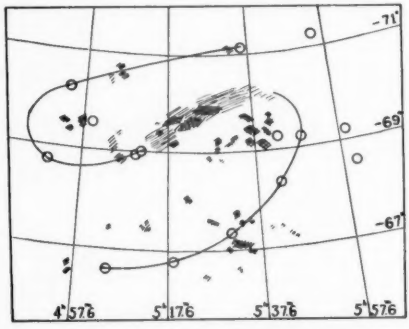

Fig. 5. Spiral configuration of globular clusters about the greater Magellanic cloud. Drawing of cloud made from plate facing page 187, Lick Observatory Publications, Vol. 13.

globular clusters about the greater cloud, and the agreement of observation with hypothesis is striking. *Not one of the clusters is found within the central condensation of the cloud, and the spiral configuration of the outliers is unmistakable.* Here we have a case analogous to that of M 33 and much better suited to observation. The indications seem to be that *the greater Magellanic cloud is in reality a diminutive spiral galaxy,* perhaps a tenth as large as our own, or even smaller, while M 33 may be comparable in size with our system.

We see now that the difficulties in reconciling the island universe theory and the larger galaxy theory are due chiefly to *looseness of terms.* The former theory has been allowed to remain vague. The statement that the spirals are external galaxies is too indefinite, but when we *define* the island universe theory by means of the outlying cluster hypothesis it takes form, and the larger galaxy becomes a necessity, with the qualification, of course, that the galaxy proper occupies only the small central part of the space allotted to the entire system including the globular clusters. Aside from the very uncertain determinations of the distances of the coarse clusters, there is no evidence of Milky Way stars at distances which are at all comparable with the average distance of a globular cluster.

PLATE XXV

Fig. 6. Photograph of the greater Sagittarius star cloud, taken by the author with projecting lantern lens, guiding with 12-inch refractor. Exposure 145 minutes.

In conclusion we see that there are, in the main, three theories to account for the phenomena of the spirals: the island universe, the "potential island universe," (the spirals will ultimately become galaxies in accordance with Jeans' hypothesis), and the repulsion theory (which aims only at an explanation of the velocities and the distribution of the spirals). The great weight of evidence favors the first. If it can be conclusively proven that the displacements on the Mt. Wilson plates are due to real motions in the nebulae rather than to the cumulative effect of contractions in the photographic emulsion (with temperature change, moisture, and other factors) the island universe theory must be abandoned. In the meantime I think it can be reconciled with the great mass of observational data, some of which can be reconciled with no other theory.

Perhaps the stellar catastrophes which gave rise to the novae we see now in the Andromeda nebula really occurred before the first Pleistocene glaciation, and the light which reaches us from many of the nearer spirals may have begun its journey when the dinosaurs were at the height of their power. There is, perhaps, a stronger emotional appeal in the island universe theory than in others, for it makes the visible universe far greater in both space and time. To favor it on this account would be nothing short of dogmatism, but it is just as dogmatic to go to the other extreme. One cannot but hope that it will stand the test of time. Looking back over the history of astronomy we see that man's conception of the universe has been steadily growing in magnitude; its growth may not yet have reached a limit.

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ABERRATION AND RELATIVITY.

By WILLIAM H. PICKERING.

The explanation of Stellar Aberration that is given universally in our text books, and is taught in all our college astronomical courses at the present day is that if a ray SA, in Figure 1, from a star S falls

Fig. 1.

on the objective B of a telescope BC, and if during the short interval of time that the light requires to move from B to A the eye piece of the telescope as carried by the earth in its orbit, moves from C to A, then the telescope must be inclined in the direction CB instead of in that of AB. The angle CBA is called the angle of aberration, or simply the aberration of the star.

This explanation is so simple and satisfactory that it has held its own for two hundred years, although evidence was published some fifty years ago which cast grave doubt upon its truth. The evidence referred to was secured at Greenwich by no less a personage than Sir George Airy, who filled his telescope with water instead of air. Now since the velocity of light in water is appreciably less than it is in air, the interval required for the ray to move from B to A would be longer than before. This would allow the eye-piece of the telescope to move through a greater distance than from C to A, and accordingly the angle of aberration should be increased. This too is perfectly simple and obvious, and the only trouble with it is that it is not true.

As Airy himself found, the angle of aberration was exactly the same in one case as in the other. This proves conclusively that the velocity of light within the telescope has nothing whatever to do with the case. If that is so, is it not better to say at once that we do not know what causes aberration, than it is to teach what is clearly untrue?

Many years ago it was pointed out that either the sun and planets are moving through a relatively stationary ether, or secondly that the ether in the solar system is moving with the sun, or finally that while much of the ether moves with the sun, each planet carries its own little atmosphere of ether along with it. The first and last hypotheses seem more probable than the second, but since we know nothing at all

about the matter, it follows that either hypothesis may be correct. It now appears that the deflection of the ray that we call aberration, in the case of the water-filled telescope, does not occur within the telescope, since on this supposition the deflection would be very appreciably greater than is actually found to be the case. Therefore it must occur somewhere outside the instrument. Of the three hypotheses regarding the ether the only one which furnishes an outside surface moving with the earth, where the deflection might occur, is the last one. This implies therefore that the last one is the correct one, and that a shallow atmosphere of ether moves with the earth.

If we admit *(a)* that the original explanation of aberration is incorrect, and *(b)* that we have acquired a new fact regarding the ether, we must now *(c)* endeavor to find some other explanation of aberration that will take the place of the discarded one, and yet will not run

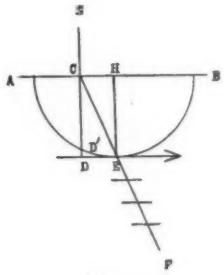


Fig. 2.

counter to the facts of observation. In Figure 2, let AB represent the dividing surface between the ether that moves with the sun and that which moves with the earth. Let the arrow indicate the direction of motion of the latter, and let DE be equal to CH, which represents the distance traversed by the earth with its atmosphere of ether, while light is moving through CD, which is equal to HE, and perpendicular to AB. When the light coming from the star S strikes the surface AB at C, it will send out a Huyghenian wave, which would normally arrive at D, but owing to the motion of the terrestrial ether will finally reach E, located on the arc drawn with H as a centre, and radius HE equal to CD.

The question now arises will this ray with its wave fronts lying parallel to AB finally reach F? In that case no aberration would occur, for in order to centre a star in our telescope, we must point the telescope perpendicular to the wave front, regardless of the direction of the ray CF. In Figure 3 with the same lettering, draw the arc ICK from E as a centre, and with radius CE. However the ether may be moving below the line AHB, Huyghenian waves starting from C and its vicinity, and traveling in the direction of E will interfere and destroy one another. Therefore the ray SC cannot reach F. On the other hand

similar waves traveling from C toward G will experience no interference. This then is the direction of the ray that proceeding from the star S will pass through the surface AHB. But on this ray the wave fronts will be parallel to the arc BD' at D', Figure 2, as shown in

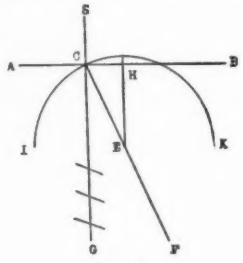


Fig. 3.

Figure 3. Our telescope must therefore be pointed perpendicular to these wave fronts, thus giving us an entirely different explanation of aberration from that heretofore universally accepted.

In this connection it may be pointed out that the light coming from a star, even considering only one wave length, does not really consist of a single series of uniform continuous waves equally spaced. On the contrary each point of the surface of the star sends out a separate sets of waves, and the final result, even for a narrow beam, is more like the surface of a pond or canal with the ripples blowing along it. They are not continuously uniformly spaced throughout the beam. The fact therefore that the wave front coming from the line AB does not form a straight continuous line cannot militate against the correctness of the explanation.

We may here mention an objection to the commonly held explanation of aberration, which every decade becomes more clearly defined. Let v be the velocity of the earth in its orbit, and V the velocity of light. Then on the older theory $v/V = \tan A$, where A is the angle of aberration. V is known with a very high degree of precision, and according to Newcomb and Michelson is equal in air to 299,778$\pm$30 km. per sec. The solar parallax, from which we derive v, is also well known, and according to independent determinations by Hinks and Perrine, as deduced from Eros, is 8″.807 $\pm$ 0″.0026. These values lead us to a result for A of 20″,471. All the latest observations however confirm the view that the value cannot possibly be less than 20″.50 and is most probably very close to 20″.52.

While the observed value is thus greater than it should be in air, and much less than it should be in water, according to the older theory, with the new theory it makes no difference with what substance we fill our telescopes, since the value should be always the same. In point of fact the observed result for air differs as much from the theoretical

value with the new theory as it does with the older one, although it eliminates the intolerable discrepancy for water, but while there appears to be no way of harmonizing these discrepancies on the older theory, with the new one several ways are open to us. These need not be considered at length in this connection however, since before attempting to theorize on this subject it is desirable to re-examine previous observations in the light of the later explanation, and particularly to determine if the computed discrepancy is relatively the same in all directions with regard to the direction of the motion of the earth, or if it is dependent on this direction. Let us suppose for instance that the centre of the earth's etherial atmosphere does not coincide with the centre of the earth, or again that this atmosphere is not exactly spherical.

But if this new explanation of aberration is correct, then there is more to follow. If the earth carries such an atmosphere of terrestrial ether along with it, then the Michelson-Morley experiment clearly implies that the velocity of light is constant with regard to the ether, just as the velocity of sound is constant with regard to our atmosphere. Moreover there appears to be no evidence whatever that it is constant with regard to an observer moving through the ether, as is stated in the Special Theory of Relativity. Much beside this that runs counter to our common sense, such as the shortening of bodies in the direction of their motion, and Minkowski's theory that time is a form of space will thus be left as mere philosophical speculations, without any physical basis of fact. Should the photographs to be taken at the coming solar eclipses of 1922 and 1923 confirm the rejected photographs taken by Crommelin in 1919, which supported Newton instead of Einstein,* and there is but little doubt that such will be the case, it is to be hoped that then astronomical science will at last escape from this mathematical mare's nest of Relativity, into which a considerable portion of the English speaking world, following a few leaders, seems to have been led, and again return to the saner views held during what the Relativitists are now pleased to call the "Prerelativity period."

April 28, 1922.

Mandeville, Jamaica, B. W. I.

DIFFERENTIAL REFRACTION IN POSITIONAL ASTRONOMY: A REVIEW.

By RALPH E. WILSON.

A careful consideration of but a small part of what has been written upon the subject of *astronomical refraction*, will convince the average reader that the present state of our knowledge, both theoretical and

*Popular Astronomy 1922, April, **30**, 201.

practical, of this highly interesting and important subject is most unsatisfactory. Almost the only definite statement we can make concerning it is that *the total amount of refraction depends not only upon the density of the various strata of air through which the ray of light passes, but also on the direction of the strata of supposedly equal density with respect to the vertical.* We do not know where refraction begins to be appreciable, though we can say that it is not sensible above a height of sixty kilometers. We do not know the law of diminution of the density of the atmosphere with height, though we have numerous hypotheses which may approximate the truth. If any one of these hypotheses be assumed as a starting point, mathematical difficulties arise in integrating the equations of refraction near the horizon. We do not know the effect of humidity, water vapor in the atmosphere. We realize that light of different wave-lengths is differently refracted but we have not yet been able to detect a color-effect on star positions. We are forced at the very beginning of any discussion of the subject to make the assumption that in the air the strata of equal density are concentric with the Earth's surface. Possibly, when the atmosphere is in a condition of equilibrium the assumption is logical but, owing to aerial currents, temperature changes and other causes, this is not universally the case. In fact, we are convinced that the times when we have stable atmospheric conditions are decidedly extraordinary and that the air-strata are generally in a continuous state of turmoil, moving back and forth, up and down, shifting the angle with respect to the vertical and changing density with temperature. In the past the astronomer has been under the necessity of neglecting all vagaries in the action of the atmosphere, for the reason that he had had no means of determining their effects. He has assumed a law of the diminution of density with height and concentric air-strata and has derived a system of refraction-corrections which approximately fit his observations.

Inasmuch as these refractions represent mean or ideal conditions which are seldom fulfilled, we should expect to find in all observations for positions outstanding discrepancies due to the departure of the actual meteorological conditions from the ideal, providing only that the observations are accurate enough to differentiate between accidental and systematic errors. Such discrepancies have been found in all modern meridian observations. In forming their fundamental systems of star-positions, Lewis Boss, Newcomb and Auwers recognized the existence of systematic errors affecting both right-ascensions and declinations and suggested various physical causes, refraction among others, to account for them. Owing, however, to the difficulty of defining the effects of the different sources of error on the observations, it became common practise to eliminate them as far as possible by proper combinations of observations and by systematic corrections derived from comparison with a fundamental catalog. The assumption, only par-

tially true, was here made that in the formation of the fundamental catalog the systematic errors had been eliminated, or at least materially reduced, by the combination of observations from many sources, taken with different instruments, under widely differing conditions and reduced by different methods. Thus were introduced into Positional Astronomy the well-known systematic corrections $\Delta\alpha_{\alpha}$, $\Delta\delta_{\alpha}$, $\Delta\alpha_{\delta}$ and $\Delta\delta_{\delta}$. The two terms depending upon the right-ascension, $\Delta\alpha_{\alpha}$ and $\Delta\delta_{\alpha}$, represent a "seasonal effect" and may be represented by the expression

$$a \sin \alpha + b \cos \alpha + c \sin 2\alpha + d \cos 2\alpha.$$

Discrepancies similar to these have been found in the observations made to determine the variation of latitude.

The refined observations of the last fifteen years have shown that, superimposed on the so-called "seasonal effect," is another and decidedly more important discrepancy, the removal of which will in itself take out a large part of the seasonal effect. The determination of the form of this discrepancy, its explanation, its effect upon the observed positions and its elimination, together with the elimination of other systematic errors, form the basis of a recent interesting and important article by Mr. William B. Varnum of the Dudley Observatory on "Differential Refraction in Positional Astronomy".[1] As this is in substance a review of Mr. Varnum's paper, quotations are made freely without the use of the customary marks.

In 1912 Tucker[2] derived a set of corrections necessary to reduce his observations of the mire at Mt. Hamilton during the early hours of the night to a standard value for the night. The following year he established[3] a difference in the effect of refraction between daytime and night observations of zenith-distance, which could be expressed in terms of a correction to the Pulkova refractions, which we assume to represent mean or ideal meteorological conditions. In 1913, also, Varnum found a diurnal term in the clock-corrections derived from 12-hour and 24-hour groups of stars observed by the Southern Expedition of the Carnegie Institution at San Luis, Argentine. For the reason that the clock used by the expedition was not kept under control, that is, under conditions of constant temperature, pressure and humidity, it was reasonable to assume that the diurnal variation observed might be due to the effect of atmospheric conditions on the clock itself. Later the same effect was found in the Albany observations which were made with the clock under perfect control. Tucker at Mt. Hamilton and Eichelberger at Washington found it in their observations and assumed it to be due somehow to the clock. It was found by Varnum in the Greenwich observations of 1907-8, two clocks being used, in the Pulkova observations of 1894-6 and in the Cape 1900 obser-

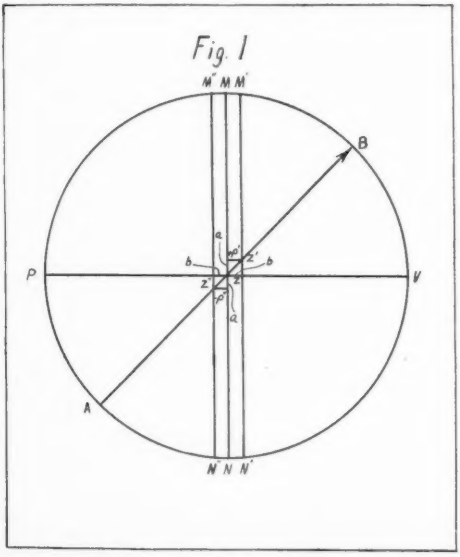
[1] Astronomical Journal, **34**, 61, 1922.
[2] Lick Observatory Bulletin **7**, 41, 1912.
[3] Idem, **7**, 130, 1913.

vations. In seven widely separated institutions, employing at least ten different clocks, the same effect has been found. The diurnal-terms in clock-rates and in zenith-distances are similar and may be expressed in the form

$$a \sin MT + b \cos MT + c \sin 2MT + d \cos 2MT.$$

But this expression represents the diurnal variation of the four meteorological coefficients of the atmosphere, shade temperature, sun temperature, barometer and humidity. It, also, represents the effect of barometer and temperature on the Pulkova refractions. In other words, the phenomenon found in the observed transits and zenith-distances is of the same form as that which exists in the meteorology, a natural phenomenon. Therefore it would seem unreasonable to attribute a systematic error in transits to as perfect a piece of mechanism as the modern astronomical clock and seek a widely different explanation for a similar term in zenith-distance. In view of the similarity between the diurnal-term in the observations and that in the atmosphere, it would seem the most natural course to examine the observations for manifestations of a refractional effect, especially in the light of our knowledge of the unsatisfactory basis of our theory of refraction.

Let us go back to the actual conditions and, instead of assuming that the strata of the atmosphere are concentric with the Earth's surface, let us consider that *there is a varying prismatic effect,* due to changes in the strata, *giving rise to changes both in angle and density.* This prismatic effect must give rise to a differential of the vertical refraction affecting both right-ascensions and declinations.



Let PV represent the prime-vertical, MN the meridian and Z the zenith. Let AB represent the direction of the prismatic displacement of the ray of light. Call μ the index of refraction of the air. If μ remained constant, we would have $F\mu$ as a constant correction to the vertical refractions already applied. μ, however, varies with the time of day and we call the rate of change of μ, ρ. In order to reduce the ρ's on different nights to the same standard we must form $\mu\rho$ and we have a second correction to our refraction of the form $F\mu\rho$. As will be seen from the Figure, when ρ is positive the star is apparently at z', while, when ρ is negative the star is apparently at z''. Or, for $+\rho$ the apparent meridian is East of the true MN, the stars transit too early and we have to apply a greater clock-correction to the transits, while for $-\rho$ the apparent meridian is West of MN, the stars transit too late and we have to apply a smaller clock-correction to the transits. A similar line of reasoning will apply to the zenith-distances. For $+\rho$ the South zenith-distances, measured from the true zenith as defined by the nadir-readings which are unaffected by atmospheric phenomena, are too small and require a positive correction, while for $-\rho$ the South zenith-distances are read too large and require a negative correction. The distances zz' and zz'' can be resolved into their rectangular components *a* and *b*, where *a* is the sine component, the shift in zenith-distance, and *b* the cosine component, the shift in right-ascension. *The total effect is essentially a shift of the meteorological zenith.*

The question arises, "Can we measure this shift?" As the effect is refractional we must get the measure of it through our refractions. The constant of refraction derived from the Pulkova tables is not the same for any two stations, so it is customary to apply to the observations a correction, CR_c, where C is a constant and R_c, the computed refraction. To this it is proposed to add the differential of the vertical refraction. A preliminary investigation showed that second order effects should be taken into account, so we have as our refraction formulae,

$$R_1 = a(1-.00116\sec^2 z)\tan z,$$

whence, by differentiation

$$dR_1 = a\sec^2 z(1.00232-.003486\sec^2 z),$$

and the complete correction for refraction in zenith-distance is

$$dR = CR_c + aF',$$

where

$$F' = \sec^2 z(1.00232-.003486\sec^2 z).$$

In right-ascension the differential refraction is of the form

$$dR = b\sec z\sec\delta\,(1-.00116\sec^2 z),$$
$$= bF,$$

where

$$F = \sec z\sec\delta\,(1-.00116\sec^2 z).$$

In order to obtain a measure of the refractional value of the at-

mosphere at any instant of time we must find some connection between these formulae and the state of the atmosphere at the time. Let us assume that the Pulkova tables, from which the vertical refractions have been computed, represent 1.0 times the refraction at standard β and γ. If we apply the logarithmic corrections, derived from Tables III, V and VII, to the logarithm of 1.0 and take out the natural number corresponding to the resulting logarithm, we get the relative refraction of the station for each period of observation, the value μ. From these relative values of the refraction we can form hourly differences, or the hourly rate of change of the refraction, ρ. We can then form $\mu\rho$. As both μ and $\mu\rho$ will produce differential effects in both coördinates, we have as our formulae for investigating the observations

$$dR = eF\mu + fF\mu\rho \quad \text{in Right Ascension,} \tag{1}$$
$$dR = CR_e + e'F'\mu + f'F'\mu\rho \quad \text{in Declination.} \tag{2}$$

The terms in $F\mu$ and $F'\mu$ represent the general drift of the refraction for the series; they tend to reconcile observations taken on different nights under different meteorological conditions and, thus, take out part of the seasonal effect. $F\mu\rho$ and $F'\mu\rho$ are the diurnal terms; they reconcile the observations taken at different times of the day and take out the remainder of the seasonal effect. If we had perfect knowledge of the meteorology and its effect upon the refraction, these formulae would be sufficient to determine the effects of differential refraction on observations for position. Upon investigation, however, it was found that, in all cases, the formulae undercorrect, especially for the daytime observations. It must be kept in mind that the Pulkova Tables do not take into account the relative humidity of the atmosphere and, more important, that shade temperatures were used while, as a matter of fact, the daytime observations were made not in the shade but in sunshine. Further investigation shows that, if humidity and sun temperatures are taken into account, the diurnal term in the observations is eliminated, and leads to the conclusion that this term is due directly to the diurnal changes of the atmosphere following the law

$$F\mu\rho = F\mu\,[a \sin(\alpha - \odot) + b \cos(\alpha - \odot) + c \sin 2(\alpha - \odot) + d \cos 2(\alpha - \odot)], \tag{3}$$

where $\odot$ = Apparent Right Ascension of Sun.

While we are forced to rely upon imperfect meteorology to determine the values of μ, it is quite evident that the values of ρ can be determined from the observations by means of (3) without recourse to the meteorology. In other words *the hourly rate of change of the refraction can be determined from the observations without a knowledge of the atmospheric change causing it.*

Formulae 1 and 2, modified by 3, then, suffice for a study of the effect of differential refraction on meridian observations in the present state of the subject. Applying them to the Albany and San Luis fundamental observations, Varnum reaches the following conclusions:

1. The diurnal-terms in both right-ascension and declination are eliminated, bringing into accordance observations taken at different times of the day.

2. The systematic errors $\Delta\alpha_\alpha$ and $\Delta\delta_\alpha$, the seasonal effects, are eliminated, bringing into accordance observations taken at different times of the year.

3. Observations on different nights in the same season are brought into better agreement.

4. Better agreement is secured between observations made north and south of the zenith without the application of a constant, as has been customary.

5. The differences between positions observed at upper and lower culminations are substantially reduced.

6. The systematic errors $\Delta\alpha_\delta$ and $\Delta\delta_\delta$ are materially reduced.

That the total effect of the differential refraction is essentially a shift

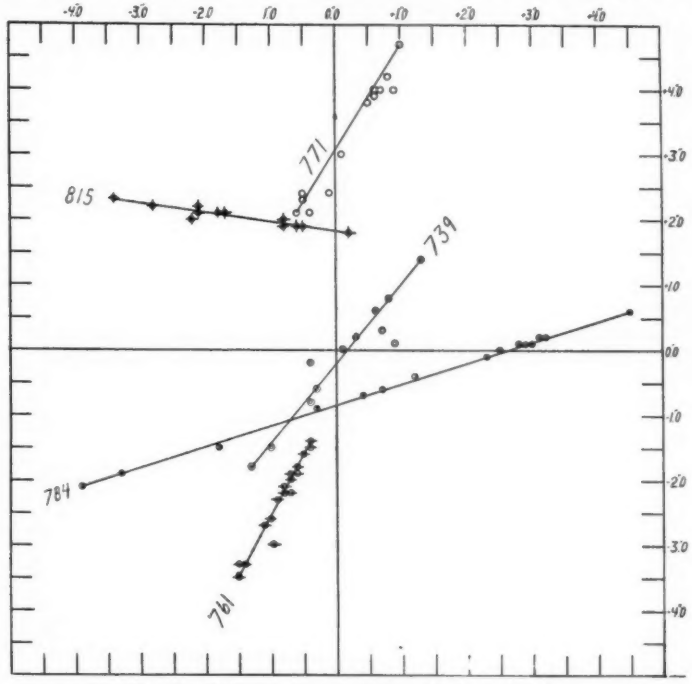
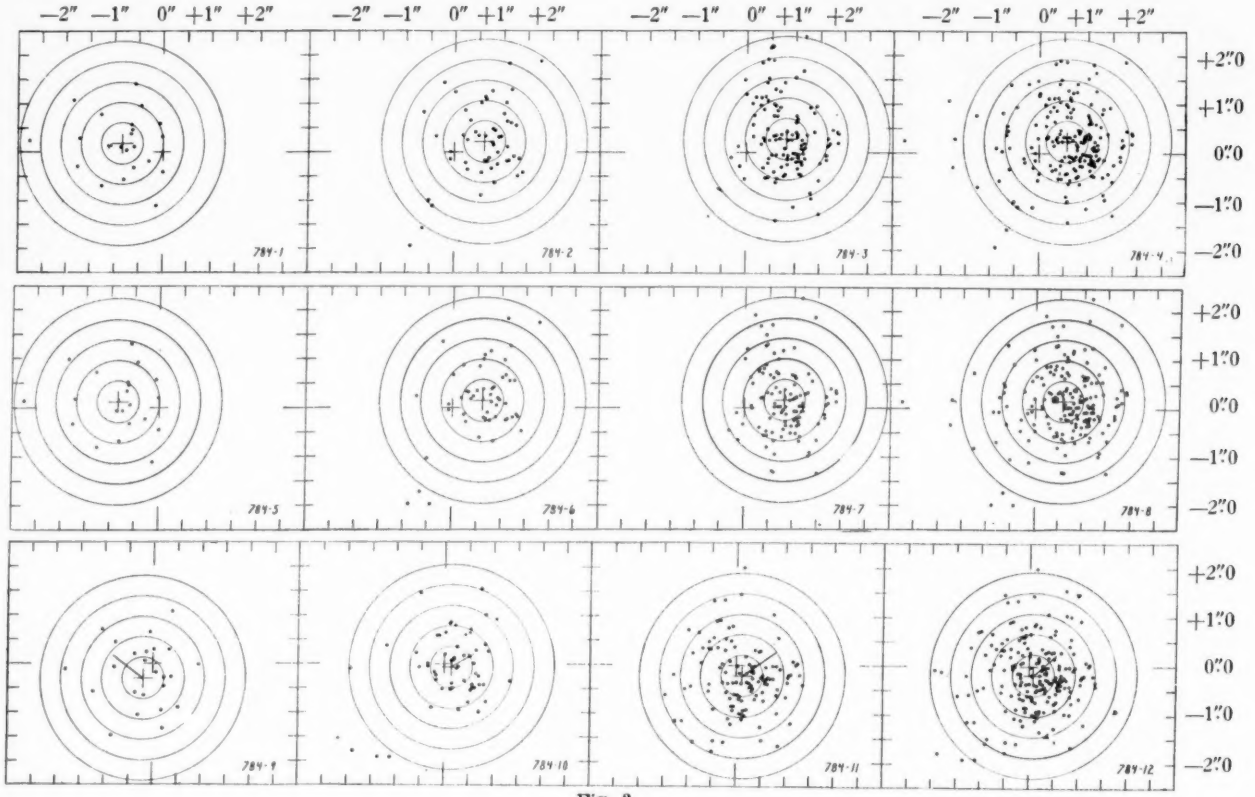


Fig. 2. Ephemerides of Meteorological Zeniths.

of the meteorological zenith is shown in Fig. 2, in which are depicted the ephemerides of the meteorological zeniths for five series of Albany observations. The spread of the observations represents the range of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784-9
784-10
784-11
784-12

Fig. 3.

the diurnal change; the distance from the true zenith, the drift for the series. The fact that the separate determinations of the positions of the meteorological zenith, based upon imperfect data, fall so nearly on a straight line is in itself good evidence that we are dealing with a positive phenomenon and that we are able to measure its effects.

The effect of differential refraction on the individual observations is depicted in Fig. 3, in which are shown the residuals from the true zenith of all the stars of series 784 of the Albany observations, omitting none. Nos. 1-4 show the uncorrected residuals, Nos. 5-8, corrected for ordinary refraction and Nos. 9-12, corrected in addition for differential refraction. In each set of diagrams, the first shows the morning observation, the second, the afternoon and the third, the night, while the fourth contains all the observations. In Nos. 5-8, the line to the right of the mean zenith of the observations indicates the amount by which the zenith has been moved by correction for ordinary refraction. In Nos. 9-12 the line indicates the total shift due primarily to the correction for differential refraction. Inasmuch as in this series the diurnal change was almost wholly in right-ascension, the shift of the mean zenith of the observations in this coördinate is most noticeable. The uncorrected morning observations define a zenith considerably to the left of the true zenith, the afternoon observations lie to the right and those taken at night lie still further away to the right. Straight refraction has no effect upon the right-ascension and so cannot reduce the diurnal variation. The application of the correction for differential refraction, however, shifts the morning observations to the right and the afternoon and night to the left, practically eliminating the diurnal variation and defining a zenith from a single series of stars which is very close to the true zenith.

That this effect is not purely local or confined to the Albany and San Luis observations is evidenced from discussions of observations taken at Mt. Hamilton and Washington. Here it is shown that even with very meagre knowledge of the meteorology,—that of Mt. Hamilton being taken from the records of San Francisco, 70 miles away and with 4000 feet difference in elevation—the systematic errors discussed are definitely reduced.

Differential refraction of the form discussed by Varnum offers a reasonable explanation in the Variation of Latitude work for the large differences between observations on successive nights, for the diurnal variation of latitude and for the Kimura term. It is probably the cause of different systematic errors in catalog positions depending upon whether bright or faint stars are used. In the observations of the bright stars, taken more or less throughout the twenty-four hours of the day the effect will tend to eliminate, but for the faint stars which are always taken at night, it will not. The question is also raised as to what extent the neglect of this phenomenon may have affected the

observations of the Sun, Moon and planets, both directly and indirectly through the adopted clock corrections.

While further study is needed, especially of the determination of the values of μ, there can be little doubt that through the application of the formulae derived to express the effect of differential refraction we can obtain from the observations and the accompanying meteorology a fairly approximate measure of the changes in refraction following atmospheric changes. Thus, Mr. Varnum's work constitutes a real advance in our knowledge of the subject of astronomical refraction and promises to open a field for future investigation for the improvement of the present refraction tables and possibly of our knowledge of the diminution of the density of the air with height.

Dudley Observatory, Albany, N. Y.,
May 1, 1922.

A UNIVERSAL SCALE FOR THE SOLUTION OF ASTRONOMICAL PROBLEMS.

By J. ERNEST G. YALDEN.

Two very interesting articles on the graphical solution of astronomical problems having recently appeared* in POPULAR ASTRONOMY has led me to offer this description of a Universal Scale recently devised for that purpose.

Practically all the astronomical "problems of position" require the solution of the astronomical triangle, or of some other spherical triangle of the celestial sphere, from the given data.

The graphic solution of problems in plane trigonometry is a simple matter, for the triangle may be drawn on a plane surface from the given data and the unknown parts then measured with scale or protractor directly from the diagram. The problems of spherical trigonometry are however another matter, for spherical triangles cannot be drawn upon a plane surface.

If one has a globe well mounted, with accurately divided circles, the solution of such triangles with tolerable accuracy is an easy matter, and such globes are still used to some extent in the solution of problems in navigation, such as those of star identification and great circle sailing.

All graphic methods of solution are inferior in accuracy when compared with a numerical one by the methods of spherical trigonometry, but they are sufficient for many purposes where only an approximate result is required.

Many graphic methods for the purpose have been devised, those

*A graphical solution for common astronomical problems, Jerry H. Service Vol. XXVI. No. 9. A graphical solution of the astronomical triangle. W. Carl Rufus Vol. XXVII. No. 4.

best known being based upon the principle of either the stereographic, or the orthographic, projection of the sphere.

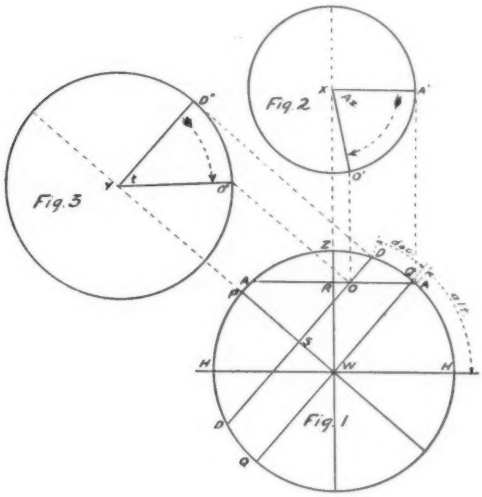
The methods described in the articles mentioned are applications of the orthographic projection of the sphere, but the one drawback to that form of solution is the necessity of making a separate diagram for the solution of each problem.

The method about to be described does not require a projection of the sphere to be made for each problem, and is therefore much more expeditious, and capable of greater accuracy.

The device consists of two diagrams which, once made, serve the purpose for the solution of any problem. The first I term the Analemma, for it is the orthographic projection of half the celestial sphere on the plane of the meridian; the second is a Universal Scale which is used for measuring azimuth and hour angle in terms of arc or time.

These diagrams should be carefully drawn on a sheet of bristol board, and to as large a scale as practicable. Problems are solved by placing a sheet of tracing paper on the diagram, and drawing thereon the lines which locate the position of the celestial body on the sphere. The tracing paper is then moved upon the Universal Scale, and the segments of the lines representing the azimuth and hour angle are directly measured in terms of arc or time.

Principles of the Diagrams.



Figs. 1, 2, and 3 illustrate the principle, and application, of the Analemma and Universal Scale.

Fig. 1. Orthographic projection of the celestial sphere. *O* a celes-

tial object situated on *AA*, a circle of altitude, and on *DD*, a circle of declination.

Fig. 2. A plan of the altitude circle *AA*, where angle *A'XO'* is the azimuth of the object *O*.

Fig. 3. A plan of the declination circle *DD*, where angle *D"YO"* is the hour angle of the object *O*.

In Fig. 1 *RO* is the cosine of the azimuth of the object *O*, and *SO* is the cosine of the hour angle of the same object, to radii *RA* and *SD* respectively.

The measure of these lines in arc and time can be obtained directly from the Universal Scale.

The Analemma.

The analemma is the orthographic projection of half the celestial sphere made for convenience—but not necessarily so—for the latitude of the observer.

It may well be made 10 inches in diameter, and the circumference divided into degrees from the South point of the horizon to the Pole, serving at the same time to measure either declination or altitude.

NWS represents the observer's horizon, *PW* an hour circle—*VI* or *XVIII* hour—passing through the Pole and the West point of the horizon, *ZW* a vertical circle—the Prime Vertical—and *WQ* the equinoctial.

The Universal Scale.

This consists of an isosceles triangle whose base is equal in length to the diameter of the Analemma, and having any convenient height. Lines parallel to the base are drawn as shown.

The base is divided into segments, on each side of the center, which represent the natural cosines of angles ranging from 5 to 85 degrees, to a radius equal to one-half the length of the base. For example distance *VI-I*, representing the cosine of one hour, or 15 degrees, equals 966 parts when *VI-O* equals 1000 of those parts. By using a scale of 100 parts to one inch three decimal places may be conveniently laid down.

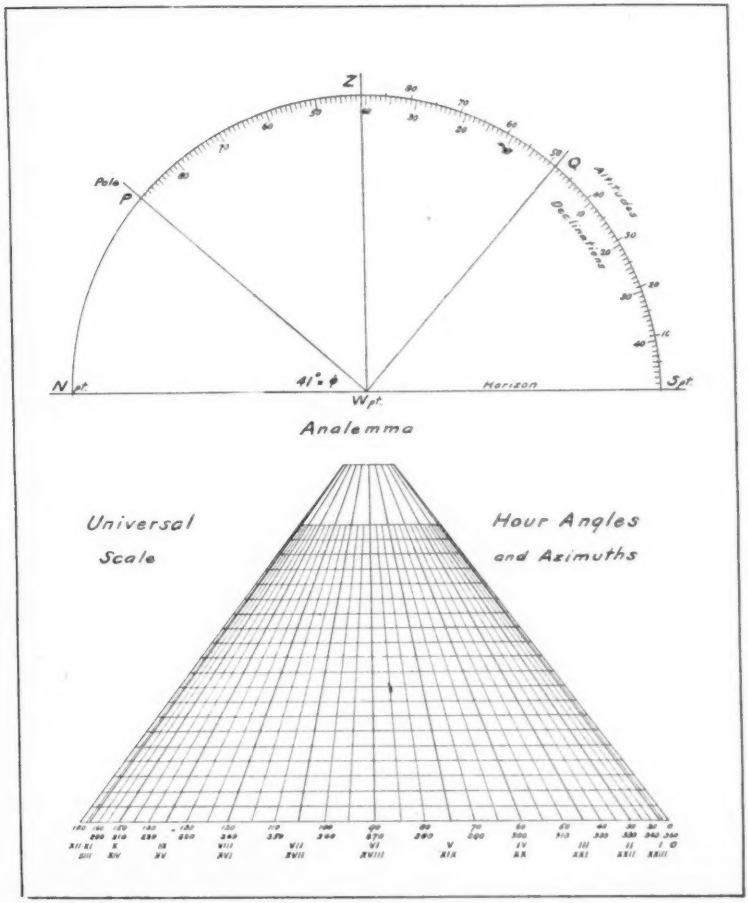
From each of these points on the base, lines are drawn to the vertex of the triangle. The divisions are numbered in arc and time as shown, and can be read directly to 5 degrees of arc, or to 20 minutes of time. Closer readings are made by estimation. The lines drawn parallel to the base are in consequence divided proportionately to the base.

An Example.

The method of using the device is perhaps best illustrated by solving an example. In my Note Book I find a Time Sight of the Sun made on July 23, 1917. Data: Sun bearing S 80° E true, altitude 41° 14′ and declination 20° 8′ N.

This is a case of knowing the latitude of the observer, and the declination, altitude and position of the Sun relative to the meridian, to determine the Sun's hour angle and azimuth.

Fig. 4 shows the only lines that require to be drawn for the solution of this problem. Having placed a sheet of tracing paper upon the Analemma, we draw the line *RA* parallel to the horizon, and through the division on the altitude scale equal to the given altitude. This may well be done with two draughtsmen's triangles, or a parallel rule. Then draw the line *SD* parallel to the equinoctial, and through the given declination on the declination scale. In each case mark the points where these lines cut the circumference, the *VI* hour circle, and the prime vertical. The point of intersection *O*, of these lines *RA* and *SD*, is the position of the Sun, while the segment *RO* represents its azimuth, and *SO* its hour angle.



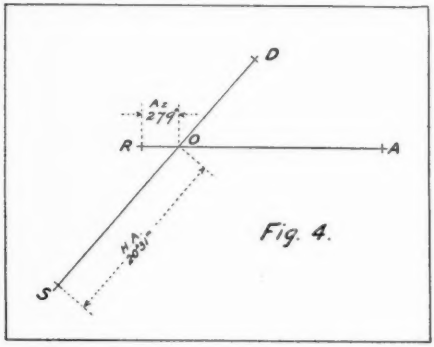


Fig. 4.

Then placing this tracing upon the Universal Scale we can measure the azimuth as follows. Fit the line *RA* between the *VI* and *O* hour lines of the Scale, keeping it parallel to the base line. The point *O* on the line *RA* will then be seen to fall nearly above the 280° line on the Scale, or 279° by estimation. By a similar procedure we find the segment *SO* to be an hour angle of $20^h\ 31^m$, or $8^h\ 31^m$ A. M.

By numerical computation the hour angle or L. A. T. was $8^h\ 30^m\ 38^s$, and the azimuth 278° 56′, showing that in many cases we can count upon this method to within about 30 minutes of arc.

Many other applications may be made with surprising rapidity where only an approximate result is required. For example the transformation of co-ordinates from horizon to equator system, required when an alt-azimuth instrument is to be set upon a given star. Also the identification of unknown stars, and the bearing of a star at a given time.

THE LYRID METEOR SHOWER.

By P. C. DANIELS AND P. C. MEAD.

The first days of the Lyrid Meteor Shower (Apr. 17-22) were cloudy at the Drake Observatory, but the nights of the 21st and 22nd were very clear and a large number of meteors was recorded. Of these thirty were accurately plotted and legended. Observations on the 21st were made from $10^h\ 30^m$ to $14^h\ 25^m$, and on the 22nd from $11^h\ 55^m$ to $13^h\ 25^m$.

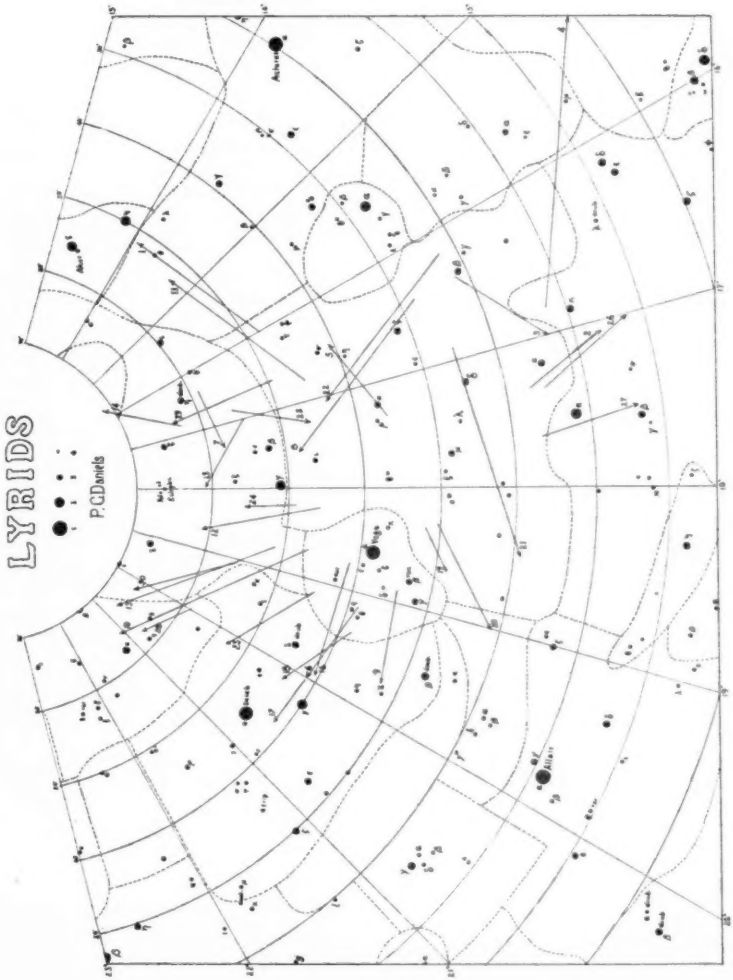
The meteors were very swift and far from the radiant, and consequently long. The maxima of both evenings came between 13^h and 14^h. The Lyrids were blue-white, practically without exception, but five orange meteors (Nos. 3, 8, 13, 21, 22.) can be traced back to a well

defined radiant R. A. 243°, declination 23°. These meteors all had trains and No. 21 in particular had a train lasting five seconds. The color, magnitude and duration can be summed up as follows.

Color	R	O	Y	G	B	V	W
Number	1	7	1	0	20	0	1

Magnitude	1	2	3	4	5
Number	4	11	8	5	2

Duration	½5—1ˢ	1—2ˢ	2—3ˢ
Number	7	17	6

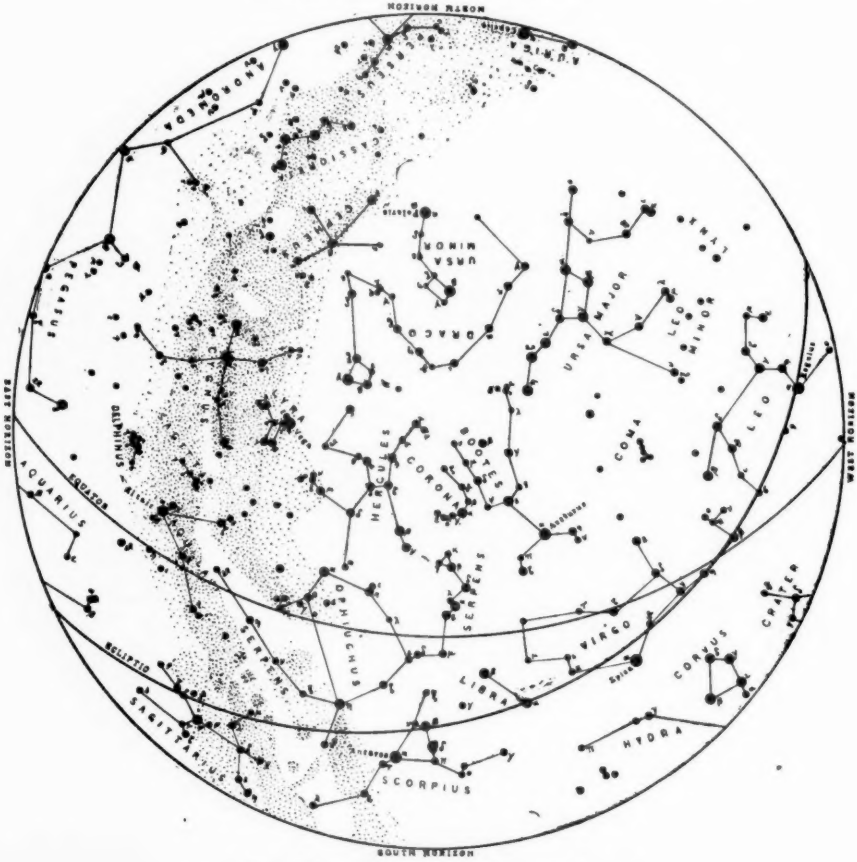


PLANET NOTES FOR JULY AND AUGUST.

(Central Standard Time.)

The phases of the *moon* will occur as follows:

	d	h	m	
First quarter	July 1	4	51.9	P. M.
Full moon	8	9	07.3	P. M.
Last quarter	16	11	11.0	P. M.
New moon	24	6	47.1	A. M.
First quarter	30	10	21.6	P. M.
Full moon	Aug. 7	10	18.7	A. M.
Last quarter	15	2	45.8	P. M.
New moon	22	2	34.0	P. M.
First quarter	29	5	54.9	A. M.



THE CONSTELLATIONS AT 9:00 P. M. JULY 1.

Mercury reaches the western extremity of its loop in Taurus about June 30 and will move eastward, reaching Cancer in August. The planet reaches greatest western elongation at midnight of July 10, perihelion at 9 A. M. July 28 and superior conjunction at midnight of August 6.

Venus will be in the eastern part of Cancer on July 1 and will move eastward to a position very near Spica by the end of August. The planet will be close to the crescent moon on the evening of July 27 and will be south of Jupiter only 2° 29′ at midnight of August 26.

The *earth* will be in aphelion at 3 P. M. July 2 at which time its distance from the sun will be 94,400,000 miles.

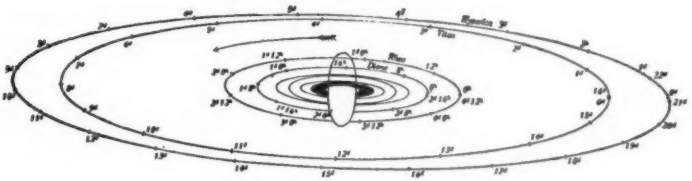
Mars will be nearly stationary in Scorpio during July and only a few degrees east of Antares. During August the planet moves slowly eastward reaching the western boundary of Sagittarius by the end of the month. Mars will be in good position for evening observation during the entire period.

Jupiter and *Saturn* will remain in Virgo and will be a few degrees northwest of Spica. The planets will be in fair position for observation during July but will be low in the west after sunset in August.

Uranus will be in Aquarius and in position for observation during the late hours of the night. Its position on August 1 will be R. A. $22^h\ 58^m\ 8^s$, Dec. —7° 28′ 10″.

Neptune will be in the western portion of Cancer but, as it will be in conjunction with the sun on August 8, it will not be in position for observation.

Saturn's Satellites.



Greatest elongations visible in the United States.

[From the *American Ephemeris.*]

CENTRAL STANDARD TIME. NOON = 0^h

I. Mimas. Period $0^d\ 22^h.6$.

1922	d	h		d	h		d	h		d	h
July	2	12.8 W	July	6	7.3 W	July	14	7.6 E	July	22	7.9 W
	3	11.5 W		11	11.8 E		19	12.0 W		23	6.6 W
	4	10.1 W		12	10.4 E		20	10.7 W			
	5	8.7 W		13	9.0 E		21	9.3 W			

II. Enceladus. Period $1^d\ 8^h.9$.

July	1	7.6 E	July	8	4.1 E	July	15	0.6 E	July	21	21.1 E
	2	16.5 E		9	13.0 E		16	9.5 E		23	6.0 E
	4	1.4 E		10	21.9 E		17	18.4 E		24	14.0 E
	5	10.3 E		12	6.8 E		19	3.3 E		25	23.8 E
	6	19.2 E		13	15.7 E		20	12.2 E		27	8.6 E

III. Tethys. Period 1d 21h.3.

July	2	20.8	E	July	10	10.1	E	July	17	23.4	E	July	25	12.6	E
	4	18.1	E		12	7.4	E		19	20.7	E		27	10.0	E
	6	15.4	E		14	4.7	E		21	18.0	E		29	7.3	E
	8	12.7	E		16	2.0	E		23	15.3	E				

IV. Dione. Period 2d 17h.7.

July	3	8.8	E	July	11	14.0	E	July	19	19.1	E	July	28	0.3	E
	6	2.5	E		14	7.7	E		22	12.8	E		30	18.0	E
	8	20.2	E		17	1.4	E		25	6.6	E				

V. Rhea. Period 4d 12h.5.

July	3	6.5	E	July	12	7.5	E	July	21	8.5	E	July	30	9.5	E
	7	19.0	E		16	20.0	E		25	21.0	E				

VI. Titan. Period 15d 23h.3.

July	3	14.3	W	July	11	16.7	E	July	19	14.0	W	July	27	16.5	E

VII. Hyperion. Period 21d 7h.6.

July	2	14.7	E	July	11	19.3	W	July	23	21.0	E	

NOTE:—E, Eastern Elongation; I, Inferior Conjunction (south of planet); W, Western Elongation; S, Superior Conjunction (north of planet).

Phenomena of Jupiter's Satellites.

VISIBLE AT WASHINGTON.
[From the *American Ephemeris.*]
CENTRAL STANDARD TIME. NOON = 0h

1922		h	m			1922		h	m		
July	1	9	12	III	Sh. I.	Aug.	1	8	36	II	Sh. I.
	3	9	05	I	Oc. D.			8	51	II	Tr. E.
	4	7	43	I	Sh. I.		6	7	12	III	Sh. E.
		8	39	I	Tr. E.		11	7	50	I	Oc. D.
		9	53	I	Sh. E.		12	7	23	I	Tr. E.
	7	8	53	II	Tr. I.			8	24	I	Sh. E.
	8	7	56	III	Tr. I.		13	7	15	III	Tr. E.
		10	25	III	Tr. E.			9	09	III	Sh. I.
	9	9	07	II	Ec. R.		17	6	49	II	Oc. D.
	11	8	23	I	Tr. I.		19	7	11	I	Tr. I.
		9	38	I	Sh. I.			8	09	I	Sh. I.
		10	34	I	Tr. E.		20	7	30	I	Ec. R.
		11	48	I	Sh. E.			9	04	III	Tr. I.
	12	8	57	I	Ec. R.		26	6	31	II	Tr. E.
	19	7	09	III	Ec. D.			8	15	II	Sh. E.
		7	26	I	Oc. D.		27	6	20	I	Oc. D.
		9	16	III	Ec. R.		28	6	42	I	Sh. E.
		10	52	I	Ec. R.						
	20	7	00	I	Tr. E.						
		8	11	I	Sh. E.						
	25	8	29	II	Sh. E.						
	26	8	38	III	Oc. R.						
	27	7	56	I	Sh. I.						
	28	7	16	I	Ec. R.						

NOTE:—I. denotes ingress; E., egress; D., disappearance; R., reappearance; Ec., eclipse; Oc., occultation; Tr., transit of the satellite; Sh., transit of the shadow.

Occultations Visible at Washington.

[*From the American Ephemeris.*]

Date 1922	Star's Name	Magnitude	IMMERSION. Washington M.T.	IMMERSION. Angle from N	EMERSION. Washington M.T.	EMERSION. Angle from N	Duration
			h m	°	h m	°	h m
July 7	95 B. Sagittarii	5.7	16 14	60	17 11	281	0 57
8	ρ Sagittarii	4.0	14 49	69	16 02	262	1 13
11	96 B. Aquarii	6.5	15 14	82	16 36	227	1 22
13	316 B. Aquarii	6.5	10 43	105	11 40	216	0 57
17	ξ Arietis	5.5	11 23	63	12 15	263	0 53
Aug. 6	τ Capricorni	5.2	7 55	79	9 14	260	1 20
8	150 B. Aquarii	6.0	8 38	120	9 29	207	0 51
14	147 B. Arietis	5.8	16 30	61	18 00	258	1 30
18	26 Geminorum	5.2	15 41	43	16 26	311	0 45
28	θ Librae	4.4	7 07	147	8 01	232	0 54

VARIABLE STARS.

Variable Star of the W Cephei Type.—An examination of Harvard photographs confirms the variability, through a small range in magnitude, of the star H. D. 42474 = B. D. +23° 1243. The variability of the star was announced in 1901 by Backhouse (Obs. **24**, 198), but has not been admitted to variable star catalogues.

Mr. Milton Humason, of the Mount Wilson Observatory, has announced in the April Publications of the Astronomical Society of the Pacific that the spectrum is peculiar, the bright lines closely resembling those of Boss 5650 and W Cephei, both of which are slightly variable in light. The irregular variability of W Cephei was announced in H. B. 764. The peculiarities in the spectrum of Boss 5650 have been described by Adams and Joy in the Publications of the Astronomical Society of the Pacific, **33**, 263, 1921.

All three stars of this peculiar group are in the Milky Way.

Harvard College Observatory Bulletin 767.

Decreasing Period of RR Cassiopeiae 235053.—The long period variable star RR Cassiopeiae has been measured by Miss Applegate on two hundred Harvard photographs covering the interval from 1889 to 1918. Miss Leavitt's discussion of the observations shows that an abrupt shortening of the period by eight per cent occurred in the years 1905 and 1906. Before 1905 the period was maintained, with some fluctuations, at 314 days. For the last twelve years the period has been approximately 290 days.

The change in the period is verified by visual observations from 1905 to date, according to a discussion made by Mr. Campbell of an extensive series of observations, including those submitted by the American Association of Variable Star Observers and the Variable Star Section of the British Astronomical Association.

The mean visual range is from 10.8 to 13.2. The light curve, which is more or less symmetrical, with the maximum longer in duration than the minimum, resembles very closely the curves derived for R Arietis, 021024, and R Virginis, 123307.

Harvard College Observatory Bulletin 767.

Minima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1922							
					July				August			
	h m	° ′		d h	d h		d h		d h		d h	
SY Androm.	0 08.0	+43 09	9.5—13.0	34 21.8	6 4				10 2			
RT Sculptor.	31.5	—26 13	9.6—10.5	0 12.3	7 23		23 7		7 16		23 0	
UU Androm	38.5	+30 24	10.7—11.9	1 11.7	2 17		17 14		8 21		23 18	
U Cephei	0 53.4	+81 20	7.0— 9.0	2 11.8	5 11		20 10		4 9		19 8	
Z Persei	2 33.7	+41 46	9.4—12	3 01.4	5 7		23 15		4 20		23 5	
TW Cassiop.	37.6	+65 19	8.2— 9.0	1 10.3	4 2		18 9		1 16		23 2	
RY Persei	39.0	+47 43	8.0—10.3	6 20.7	4 21		25 11		8 5		21 22	
RZ Cassiop.	39.9	+69 13	6.9— 8.1	1 04.7	2 11		23 23		14 12		28 20	
TX Cassiop.	44.4	+62 22	9.4—10.1	2 22.2	4 10		21 23		8 13		26 2	
ST Persei	53.7	+38 47	8.5—10.5	2 15.6	2 19		18 16		3 14		19 11	
RX Cassiop.	2 58.8	+67 11	8.6— 9.1	32 07.6			27 6				28 14	
Algol	3 01.7	+40 34	2.3— 3.5	2 20.8	8 21		26 2		12 6		29 11	
RT Persei	16.7	+46 12	9.5—11.5	0 20.4	1 16		22 2		4 16		25 1	
λ Tauri	55.1	+12 12	3.3— 4.2	3 22.9	2 5		18 0		2 20		26 13	
RW Tauri	3 57.8	+27 51	7.1—<11	2 18.5	4 4		20 19		6 9		23 0	
RV Persei	4 04.2	+33 59	9.5—11.0	1 23.4	3 16		19 11		4 6		20 1	
RW Persei	13.3	+42 04	8.8—11.0	13 04.8	2 15		15 20		11 5		24 10	
SZ Tauri	31.4	+18 20	7.2— 7.7	3 03.6	6 2		24 23		3 10		22 7	
RS Cephei	4 48.6	+80 06	9.5—12.0	12 10.1	2 17		15 3		8 23		21 9	
TT Aurigæ	5 02.8	+39 27	7.8— 8.7	0 16.0	1 8		21 8		3 16		17 0	
RY Aurigæ	11.5	+38 13	10.7—11.7	2 17.5	9 1		25 10		2 14		18 23	
RZ Aurigæ	42.9	+31 40	10.6—13.3	3 00.3	6 18		24 19		5 20		23 22	
SV Tauri	45.8	+28 05	9.4—11.0	2 04.0	6 12		23 20		10 4		27 12	
Z Orionis	50.2	+13 40	9.7—10.7	5 04.9	3 14		24 10		3 19		24 15	
SV Gemin.	54.6	+24 28	9.8—<11	4 00.2	2 11		18 12		3 12		19 13	
RW Gemin.	5 55.4	+23 08	9.5—11.0	2 20.8	3 22		21 3		1 14		24 12	
U Columbæ	6 11.2	—33 03	9.2—10.0	2 19.2	3 0		19 19		5 15		22 10	
SX Gemin.	22.0	+20 37	10.8—11.5	1 08.8	8 3		24 12		1 17		18 3	
RW Monoc	29.3	+ 8 54	9.0—10.8	1 21.7	2 18		18 0		2 6		17 12	
RX Gemin.	43.6	+33 21	8.8— 9.6	12 05.0	8 0		20 5		1 10		25 20	
RU Monoc.	6 49.4	— 7 28	9.8—10.5	0 21.5	7 7		21 15		4 23		19 7	
R Can. Maj.	7 14.9	—16 12	5.8— 6.4	1 03.3	5 13		19 5		9 15		22 6	
RY Gemin.	21.7	+15 52	8.9—<10	9 07.2	6 5		24 19		3 3		21 17	
Y Camelop.	27.6	+76 17	9.5—12	3 07.3	5 10		18 15		7 11		20 16	
TX Gemin.	30.3	+17 08	10.0—11.9	2 19.2	6 0		22 20		8 15		25 10	
RR Puppis	43.5	—41 08	9.4—10.7	6 10.3	3 14		17 10		4 17		24 0	
V Puppis	7 55.4	—48 58	4.1— 4.8	1 10.9	3 0		17 13		8 9		22 22	
X Carinae	8 29.1	—58 53	7.9— 8.7	0 13.0	2 8		18 13		3 19		20 1	
S Cancri	8 38.2	+19 24	8.2—10	9 11.6	6 0		24 23		3 10		22 9	
RX Hydræ	9 00.8	— 7 52	9.1—10.5	2 06.8	6 1		19 18		2 10		22 23	
S Velorum	29.4	—44 46	7.8— 9.3	5 22.4	3 4		20 23		1 20		19 15	
Y Leonis	9 31.1	+26 41	9.3—11.2	1 16.5	4 20		25 2		7 14		21 2	
RR Velorum	10 17.8	—41 36	10.0—10.9	1 20.5	7 15		22 11		6 7		21 3	
SS Carinæ	10 54.2	—61 23	12.2—12.8	3 07.2	1 15		21 10		3 15		23 10	
ST Urs. Maj.	11 22.4	+45 44	6.7— 7.2	8 19.2	9 0		17 19		4 10		22 0	
RW Urs. Maj.	35.4	+52 34	10.3—11.4	7 07.9	1 19		23 18		7 10		22 1	
Z Draconis	11 39.8	+72 49	9.9—13.6	1 08.6	5 10		25 18		8 8		21 22	
RZ Centauri	12 55.6	—64 05	8.5— 8.9	1 21.0	4 9		19 10		3 10		25 22	
RS Can. Ven.	13 06.3	+36 28	7.5—12.5	4 19.1	6 22		26 2		4 16		23 21	
SS Centauri	07.2	—63 37	8.8—10.4	2 11.5	5 15		20 12		4 9		19 6	
133926 Hydræ	13 39.0	—26 23	8.6—12.7	2 21.5	4 9		21 18		2 8		19 17	

Minima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of minima in 1922							
					July				August			
	h m	° ′		d h	d h		d h		d h		d h	
δ Libræ	14 55.6	— 8 07	4.8— 6.2	2 07.9	4 22		18 16		1 11		22 2	
U Coronæ	15 14.1	+32 01	7.6— 8.7	3 10.9	2 4		22 21		5 16		26 9	
TW Draconis	32.4	+64 14	7.3— 8.9	2 19.3	6 13		23 9		9 6		26 2	
SS Librae	15 43.4	—15 14	9.3—11.5	0 18.4	1 11		24 10		8 18		24 1	
SW Ophiuchi	16 11.1	— 6 44	9.2—10.0	2 10.7	5 8		21 0		3 16		18 9	
SX Ophiuchi	12.6	— 6 25	10.5—11.2	2 01.5	3 20		20 8		5 20		22 9	
R Aræ	31.1	—56 48	6.8— 7.9	4 10.2	2 7		19 23		6 16		24 9	
TT Herculis	16 49.9	+17 00	8.9— 9.3	20 18.1	2 3		20 21		12 15			
TU Herculis	17 09.8	+30 50	9.5—12	2 06.4	7 7		20 21		3 11		23 21	
U Ophiuchi	11.5	+ 1 19	6.0— 6.7	0 20.1	8 22		25 17		3 2		19 21	
u Herculis	13.6	+33 12	4.6— 5.4	2 01.2	5 5		23 16		4 23		23 10	
TX Herculis	15.4	+42 00	8.3— 9.0	1 00.7	5 13		24 0		5 9		23 21	
RV Ophiuchi	29.8	+ 7 19	9. —12	3 16.5	1 20		23 23		7 17		22 11	
SZ Herculis	36.0	+33 01	9.5—10.3	0 19.6	4 3		20 12		5 21		22 6	
TX Scorpii	48.6	—34 13	7.5— 8.2	0 22.6	8 6		23 8		7 10		22 12	
UX Herculis	49.7	+16 57	8.8—10.5	1 13.2	2 23		26 5		2 22		18 10	
Z Herculis	53.6	+15 09	7.1— 7.9	3 23.8	3 23		19 22		4 22		20 21	
WX Sagittarii	53.6	—17 24	9.2—10.8	2 03.1	8 4		25 4		2 17		19 18	
WY Sagittarii	17 54.9	—23 01	9.5—10.6	4 16.0	8 3		26 20		5 4		23 20	
SX Draconis	18 03.0	+58 23	9.3—10.5	5 04.1	6 14		27 6		6 14		27 7	
RS Sagittarii	11.0	—34 08	5.9— 6.3	2 10.0	2 21		27 9		8 3		22 15	
V Serpentis	11.1	—15 34	9.5—11.1	3 10.9	7 8		21 3		3 23		24 16	
RZ Scuti	21.1	— 9 15	7.4— 8.3	15 03.2	4 20		19 23		4 2		19 5	
RZ Draconis	21.8	+58 50	9.5—10.2	0 13.2	5 0		19 8		2 15		24 3	
RX Herculis	26.0	+12 32	7.0— 7.6	0 21.3	2 21		24 5		7 11		21 16	
SX Sagittarii	39.7	—30 36	8.7— 9.8	2 01.8	4 9		21 0		6 15		23 6	
RR Draconis	40.8	+62 34	9.3—13	2 19.9	7 17		24 17		2 5		19 4	
RS Scuti	43.7	—10 21	9.3—10.3	0 15.9	7 20		21 3		3 9		23 8	
β Lyræ	46.4	+33 15	3.4— 4.1	12 21.8	8 22		21 19		3 17		29 13	
U Scuti	18 48.9	—12 44	9.1— 9.6	0 22.9	3 21		19 3		3 10		18 17	
RX Draconis	19 01.1	+58 35	9.3—10.2	1 21.4	2 18		25 11		2 1		24 18	
RV Lyræ	12.5	+32 15	11. —12.8	3 14.4	1 17		16 3		6 17		21 2	
RS Vulpec.	13.4	+22 16	6.9— 8.0	4 11.4	2 20		20 18		7 16		25 14	
U Sagittæ	14.4	+19 26	6.5— 9.0	3 09.1	6 13		20 2		2 14		22 21	
Z Vulpec.	17.5	+25 23	7.3— 8.5	2 10.9	1 3		23 5		6 22		21 16	
TT Lyræ	24.3	+41 30	9.4—11.6	5 05.8	5 3		20 20		5 14		21 8	
UZ Draconis	26.1	+68 44	9.0— 9.8	1 15.1	2 9		21 22		3 23		23 13	
SY Cygni	19 42.7	+32 28	10 —12	6 00.2	3 22		21 23		2 23		20 23	
WW Cygni	20 00.6	+41 18	9.3—13.4	3 07.6	5 20		19 2		1 9		21 7	
SW Cygni	03.8	+46 01	9. —11.7	4 13.8	7 9		25 16		3 20		22 3	
VW Cygni	11.4	+34 12	9.8—11.8	8 10.3	8 15		25 12		2 22		19 19	
RW Capric.	12.2	—17 59	8.8—10.6	3 09.4	3 5		16 19		6 3		19 17	
UW Cygni	19.6	+42 55	10.5—13	3 10.8	1 14		22 7		5 2		18 21	
V Vulpec.	32.3	+26 15	8.2— 9.8	37 19.0	15 9						22 4	
W Delphini	33.1	+17 56	9.4—12.1	4 19.4	8 15		27 21		6 11		25 17	
RR Delphini	38.9	+13 35	10.5—11.8	4 14.4	2 1		20 10		7 20		26 5	
Y Cygni	48.1	+34 17	7.1— 7.9	1 12.0	2 16		17 16		1 15		16 14	
WZ Cygni	49.3	+38 27	9.9—10.8	0 14.0	1 2		16 7		8 2		23 7	
RR Vulpec.	20 50.5	+27 32	9.6—11.0	5 01.2	10 21		20 23		10 4		30 9	
VVCygni	21 02.3	+45 23	12.1—13.8	1 11.4	1 21		16 15		7 19		22 13	
AE Cygni	09.0	+30 20	10.8—11.4	0 23.3	8 17		28 2		6 19		26 4	
RY Aquarii	14.8	—11 14	8.8—10.4	1 23.2	5 20		21 14		6 8		22 1	
RT Lacertæ	21 57.4	+43 24	9.1—10.5	5 01.7	3 2		23 9		2 12		22 19	
UZ Cygni	55.2	+43 52	8.9—11.6	31 07.3			20 17				21 0	
RW Lacertæ	22 40.6	+49 08	10.2—11.2	5 04.4	4 20		20 9		4 22		20 12	
8.1914 Pegasi	51.7	+32 41	10.0—10.6	5 06.4	5 12		21 8		6 3		21 22	
TT Androm.	23 08.7	+45 36	11.3—12.6	2 18.4	1 21		18 12		4 2		20 16	
Y Piscium	29.3	+ 7 22	9.0—12.0	3 18.3	3 17		18 18		2 20		25 10	
TW Androm.	23 58.2	+32 17	8.6—11.5	4 02.9	6 15		23 3		8 15		25 2	

Maxima of Variable Stars of Short Period.

[Calculated by members of the class in General Astronomy at Carleton College.]

Given to the nearest hour in Greenwich mean time; to obtain Eastern Standard time subtract 5^h; Central Standard time 6^h, etc.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1922							
					July				August			
	h m	° ′		d h	d h	d h	d h	d h	d h	d h	d h	d h
SX Cassiop.	0 05.5	+54 20	8.6— 9.2	36 13.7	15 4						20	18
SY Cassiop.	0 09.8	+57 52	9.3— 9.9	4 01.7	7 3	23 9	8	16	24	23		
RR Ceti	1 27.0	+ 0 50	8.3— 9.0	0 13.3	1 10	16 21	1	9	16	21		
RW Cassiop.	1 30.7	+57 15	8.9—11.0	14 19.2	12 22	27 17	11	12	26	7		
V Arietis	2 09.6	+11 46	8.3— 9.0	0 23.8	7 10	23 7	8	4	24	1		
SU Cassiop.	2 43.0	+68 28	6.5— 7.0	1 22.8	3 13	19 3	3	18	27	3		
TU Persei	3 01.8	+52 49	11.4—12.2	0 14.6	4 19	19 9	2	23	24	19		
RW Camelop.	3 46.2	+58 21	8.2— 9.4	16 00.0	13	29	14		20			
SX Persei	4 10.2	+41 27	10.4—11.2	4 07.0	6 9	23 13	1	3	18	7		
SV Persei	42.8	+42 07	8.8— 9.6	11 03.1	3 14	25 20	5	23	28	5		
RX Aurigæ	4 54.5	+39 49	7.2— 8.1	11 15.0	9 2	20 17	1	8	24	14		
SX Aurigæ	5 04.6	+42 02	8.0— 8.7	1 12.8	1 2	16 10	8	9	23	17		
SY Aurigæ	05.5	+42 41	8.4— 9.5	10 03.3	10 13	20 17	11	23	30	6		
Y Aurigae	21.5	+42 21	8.6— 9.6	3 20.6	3 20	19 6	3	17	26	20		
RZ Gemin.	5 56.6	+22 15	9.1—10.0	5 12.7	4 1	20 15	6	5	22	19		
RS Orionis	6 16.5	+14 44	8.2— 8.9	7 13.6	2 6	17 10	1	13	24	6		
T Monoc.	19.8	+ 7 08	5.7— 6.8	27 00.3	11 18		7	19				
RT Aurigæ	23.0	+30 33	5.1— 6.0	3 17.5	6 18	21 16	5	13	20	11		
RZ Camelop.	23.7	+67 06	11.0—13.0	0 11.5	7 12	21 23	5	8	19	18		
W Gemin.	29.2	+15 24	6.7— 7.5	7 22.0	4 12	20 8	5	4	20	23		
ζ Gemin.	6 58.2	+20 43	3.7— 4.3	10 03.7	5 12	25 19	4	23	25	6		
RU Camelop.	7 10.9	+69 51	8.5— 9.8	22 06.5		18 7	9	14	31	20		
RR Gemin.	7 15.2	+31 04	10.0—11.5	0 09.5	7 11	23 8	8	6	24	3		
V Carinæ	8 26.7	—59 47	7.4— 8.1	6 16.7	5 16	19 1	1	11	21	13		
T Velorum	8 34.4	—47 01	7.6— 8.5	4 15.3	7 11	16 17	4	7	22	20		
V Velorum	9 19.2	—55 32	7.5— 8.2	4 08.9	2 22	20 10	6	22	24	9		
Z Leonis	9 46.4	+27 22	7.9— 9.6	59 00.0		17						
RR Leonis	10 02.1	+24 29	9.1—10.1	0 10.9	2 22	23 6	5	20	19	10		
SU Draconis	11 32.2	+67 53	8.9— 9.6	0 15.8	7 14	20 19	3	0	22	19		
S Muscæ	12 07.4	—69 36	6.4— 7.3	9 15.8	1 15	20 23	9	6	28	14		
SW Draconis	12.8	+70 04	8.8— 9.6	0 13.7	2 14	18 13	3	12	19	11		
T Crucis	15.9	—61 44	6.8— 7.6	6 17.6	5 14	19 2	1	13	21	17		
R Crucis	18.1	—61 04	6.8— 7.9	5 19.8	4 10	21 22	2	13	25	20		
S Crucis	12 48.4	—57 53	6.5— 7.6	4 16.6	2 22	17 0	4	18	18	20		
W Virginis	13 20.9	— 2 52	8.7—10.4	17 06.5	7 15	24 21	11	4	28	10		
SS Hydræ	25.0	—23 08	7.4— 8.1	8 04.8	5 19	22 5	7	14	24	0		
RV Urs. Maj.	13 29.4	+54 31	9.2— 9.9	0 11.2	3 10	17 11	7	13	21	14		
ST Virginis	14 22.5	— 0 27	10.3—11.4	0 09.9	6 12	22 22	8	9	24	19		
V Centauri	25.4	—56 27	6.4— 7.8	5 11.9	2 23	19 11	4	22	21	10		
RS Bootis	29.3	+32 11	8.9—10.0	0 09.1	2 7	17 9	1	11	16	13		
RU Bootis	14 41.5	+23 44	12.8—14.3	0 11.9	4 10	19 6	3	2	17	21		
R Triang. Austr.	15 10.8	—66 08	6.7— 7.4	3 09.3	1 7	21 15	4	5	17	18		
S Triang. Austr.	15 52.2	—63 29	6.4— 7.4	6 07.8	1 3	20 2	1	18	20	17		
S Normæ	16 10.6	—57 39	6.6— 7.6	9 18.1	5 1	24 13	3	7	22	20		
RW Draconis	33.7	+58 03	9.6—10.8	0 10.6	9 5	18 1	4	19	22	12		
RV Scorpii	16 51.8	—33 27	6.7— 7.4	6 01.5	4 8	22 12	3	15	21	20		
X Sagittarii	17 41.3	—27 48	4.4— 5.0	7 00.3	1 19	22 20	5	21	19	21		
Y Ophiuchi	47.3	— 6 07	6.1— 6.5	17 02.9	6 14	23 17	10	20	27	23		
W Sagittarii	17 58.6	—29 35	4.3— 5.1	7 14.3	4 23	20 3	4	8	19	12		
Y Sagittarii	18 15.5	—18 54	5.4— 6.2	5 18.6	4 7	21 15	2	4	25	6		
U Sagittarii	26.0	—19 12	6.5— 7.3	6 17.9	1 19	22 1	4	12	24	18		
Y Scuti	32.6	— 8 27	8.7— 9.2	10 08.3	3 10	24 2	3	11	24	3		
Y Lyræ	34.2	+43 52	11.3—12.3	0 12.1	4 8	22 10	3	12	21	14		
RZ Lyræ	18 39.9	+32 42	9.9—11.2	0 12.3	5 22	18 4	5	14	24	0		

Maxima of Variable Stars of Short Period—Continued.

Star	R.A. 1900	Decl. 1900	Magnitude	Approx. Period	Greenwich mean times of maxima in 1922							
					July				August			
	h m	° ′		d h	d	h	d	h	d	h	d	h
RT Scuti	18 44.1	−10 30	9.1— 9.7	0 11.9	6	14	18	11	5	8	23	4
κ Pavonis	18 46.6	−67 22	3.8— 5.2	9 02.2	3	1	21	5	8	9	26	14
U Aquilæ	19 24.0	− 7 15	6.2— 6.9	7 00.6	5	20	19	21	2	22	24	0
XZ Cygni	30.4	+56 10	8.6— 9.3	0 11.2	4	15	18	15	1	15	22	14
U Vulpec.	32.2	+20 07	6.5— 7.6	7 23.5	5	15	21	14	6	13	22	12
SU Cygni	40.8	+29 01	6.2— 7.0	3 20.3	4	0	19	9	3	19	19	4
η Aquilæ	47.4	+ 0 45	3.7— 4.5	7 04.2	1	23	23	12	6	20	21	5
S Sagittæ	51.5	+16 22	5.6— 6.4	8 09.2	4	9	21	3	6	22	23	16
X Vulpec.	19 53.3	+26 17	9.5—10.5	6 07.7	3	15	22	14	4	5	23	5
X Cygni	20 39.5	+35 14	6.0— 7.0	16 09.3	13	21	30	6	15	15		
T Vulpec.	47.2	+27 52	5.5— 6.1	4 10.5	3	20	17	4	3	22	21	15
UY Cygni	52.3	+30 03	9.6—10.4	0 13.5	5	5	18	16	1	3	21	7
RV Capric.	55.9	−15 37	9.2—10.1	0 10.7	6	6	19	16	2	2	22	6
TX Cygni	20 56.4	+42 12	8.5— 9.7	14 17.4	6	14	21	7	5	1	19	18
VY Cygni	21 00.4	+39 34	8.8— 9.5	7 20.6	3	23	19	15	4	9	20	2
SW Aquarii	10.2	− 0 20	9.9—10.8	0 11.0	5	11	19	6	2	1	22	17
VZ Cygni	21 47.7	+42 40	8.2— 9.2	4 20.7	3	0	17	14	1	5	20	16
Y Lacertæ	22 05.2	+50 33	9.1— 9.6	4 07.8	2	19	20	2	6	9	23	16
δ Cephei	25.5	+57 54	3.7— 4.6	5 08.8	3	15	19	17	4	19	20	22
Z Lacertæ	36.9	+56 18	8.2— 9.0	10 21.1	4	21	26	15	6	12	28	7
RR Lacertæ	37.5	+55 55	8.5— 9.2	6 10.1	6	1	18	21	7	3	20	0
V Lacertae	44.5	+55 48	8.5— 9.5	4 23.6	3	19	18	18	2	17	17	16
X Lacertæ	22 45.0	+55 54	8.2— 8.6	5 10.7	4	11	20	18	6	2	22	11
SW Cassiop.	23 03.7	+58 11	9.2— 9.7	5 10.6	2	5	18	15	3	23	20	7
RS Cassiop.	32.6	+61 52	9.0—11.0	6 07.1	3	1	21	23	3	13	22	10
RY Cassiop.	47.2	+58 11	9.3—11.8	12 03.4	8	0	20	3	13	10	25	14
V Cephei	23 51.7	+82 38	6.0— 7.0	0 23.9	5	20	19	19	2	18	23	17

Naming of Recently Discovered Variable Stars.—In the *Astronomische Nachricten* No. 5143 is given a list of the names and positions of 96 recently discovered variable stars.

No.	Name	R.A.1900 h m s	Dec.1900 ° ′	Brightness Max.	Min.		Remarks
1	TZ Cephei	0 19 17	+73 22.0	10.3	12.0	ph	Short period
2	XX Cassiopiae	1 23 00	+60 27.4	9.4	10.7	ph	Algol type
3	X Trianguli	1 54 52	+27 24.0	9.1	10.9	ph	Algol type
4	SS Eridani	3 07 03	−12 15.3	11	...	ph	
5	XY Persei	3 42 57	+38 39.5	9.0	10.5	ph	Algol type
6	UY Tauri	3 48 45	+15 43.1	10.5	16	ph	Period 335 days?
7	XZ Persei	4 02 17	+46 18.6	11.0	12.2	ph	Short period
8	YY Persei	4 29 18	+44 46.3	8.8	9.4	v	Short period
9	AB Aurigae	4 49 23	+30 24.0	7.0	8.9	ph	Irregular
10	AC Aurigae	5 19 15	+50 01.6	10.6	<13.6	ph	
11	AD Aurigae	5 22 06	+38 58.0	11.0	12.1	ph	Short period
12	BO Orionis	5 30 45	− 4 28.8	13.6	15.3	ph	Irregular
13	BP Orionis	5 32 32	− 5 27.3	15.4	16.3	ph	
14	WW Geminorum	6 06 00	+23 31.6	9.7	10.5	ph	
15	V Leporis	6 06 40	−20 11.5	9.2	10.3	ph	Algol type
16	SY Monocerotis	6 31 27	− 1 18.3	9.6	<13.5	ph	Long period
17	WX Geminorum	6 38 52	+32 24.9	10.3	11.2	ph	Short period
18	ST Puppis	6 45 30	−37 09.7	9.5	10.5	ph	
19	SZ Monocerotis	6 45 25	− 1 15.0	10.6	11.8	ph	Short period
20	Z Canis maj.	6 59 02	−11 23.7	8.9	11.0	ph	Irregular
21	TT Monocerotis	7 20 46	− 5 38.9	8.4	<13.2	ph	Long period
22	TU Monocerotis	7 48 18	− 2 46.7	9.0	10.9	ph	Algol type

No.	Name	R.A.1900 h m s	Dec.1900 ° ′	Brightness Max.	Min.		Remarks
23	SU Puppis	7 52 58	−43 52.6	9.2<	13.6	ph	
24	Z Lyncis	8 00 37	+58 06.7	8	9.5	v	
25	SV Puppis	8 12 37	−13 29.8	9.5<	13.1	ph	Long period
26	SW Puppis	8 15 15	−42 26.4	9.3	10.3	ph	Short period
27	SY Hydrae	8 25 02	− 9 04.1	10.7<	13.6	ph	Algol type
28	V Pyxidis	8 49 26	−34 26.2	8.6	11.0	ph	Irregular
29	SZ Hydrae	9 08 58	− 8 54.4	9.9	11.3	ph	
30	RR Antliae	9 31 38	−39 27.1	9.3	10.9	ph	
31	SU Leonis	9 48 20	+ 8 27.0	11	13	ph	Short period
32	SV Leonis	9 57 00	+27 10.6	11.4<	15.4	ph	Period 307 d±
33	CK Carinae	10 20 54	−59 40.9	8.8	10.1	ph	
34	VZ Velorum	10 24 12	−50 40.0	10.4	12.5	ph	
35	WW Velorum	10 46 06	−48 09.0	10.8	14	ph	
36	CL Carinae	10 50 03	−60 33.6	9.6	11.0	ph	
37	SW Leonis	10 50 50	− 2 26.9	12.5	13.5	v	
38	AL Centauri	12 30 32	−53 03.0	9.8	10.7	ph	
39	UW Virginis	13 10 01	−16 56.8	9.0<	12.1	ph	Algol type
40	UX Virginis	13 35 36	+ 7 38.3	13	14.5	v	
41	RV Canum Ven.	13 35 41	+28 49.0	13.5	14.5	v	Period $3^h\ 14^m$
42	AM Centauri	13 40 54	−52 52	10.4	11.6	ph	
43	AN Centauri	13 42 06	−37 38	11.5<	14	ph	
44	RW Lupi	14 19 58	−43 41.8	10.4	11.8	ph	
45	AO Centauri	15 54 18	−42 05.2	10.6<	12.5	ph	
46	AP Centauri	14 54 59	−34 05.1	10.4<	13.5	ph	
47	TT Librae	15 02 24	−15 07	10.9	16	ph	
48	RV Triang. austr.	15 23 36	−62 13	12.0<	13.2	ph	
49	TU Librae	15 29 30	−23 37	11.4	14.5	ph	
50	RX Lupi	15 39 24	−47 45	10.0<	14	ph	
51	RY Lupi	15 52 43	−40 04.9	10.6	12.1	ph	
52	RY Coronae	16 19 09	+31 03.5	9.9	11.0	ph	Short period
53	SY Arae	16 27 20	−54 32.6	10.1<	11.9	ph	Algol type
54	WZ Ophiuchi	17 01 48	+ 7 45	9.1	10.1	v	Algol type
55	SV Arae	17 02 00	−61 49	11.7	13.3	ph	
56	RZ Pavonis	17 40 07	−58 42.4	10.5<	13.5	ph	Long period
57	BN Sagittarii	17 40 46	−28 07.1	9.6	10.6	ph	Short period
58	BN Scorpii	17 47 32	−34 19.2	12.3	15.2	ph	Long period
59	TT Arae	17 56 24	−47 14	11.0<	14	ph	
60	RY Coronae austr.	18 14 36	−44 57	11.9<	14	ph	
61	AC Herculis	18 26 02	+21 47.6	7.4	9.0	ph	Short period
62	TY Scuti	18 36 50	− 4 23.4	9.4	10.5	v	Algol type
63	AD Herculis	18 45 43	+20 36.4	9.5	10.0	ph	
64	SV Telescopii	18 48 36	−49 36	10.0<	12.8	ph	
65	RZ Coronae austr.	19 01 36	−42 31	10.4<	13.5	ph	
66	SW Telescopii	19 20 18	−46 04	11.0	14	ph	
67	BO Sagittarii	19 34 30	−44 50	12.0<	15.0	ph	
68	BR Cygni	19 37 54	+46 32.7	9.3	10.4	ph	
69	BP Sagittarii	19 40 14	−44 42.9	10.5<	13.5	ph	
70	XX Aquilae	19 45 53	− 0 50.5	13.2	14.9	ph	
71	SV Vulpeculae	19 47 25	+27 11.9	7.7	9.6	ph	
72	BS Cygni	19 49 15	+53 26.3	13	<16	ph	
73	BT Cygni	19 57 29	+50 24.2	11	<16	ph	
74	CD Cygni	20 00 37	+33 49.6	8.9	10.7	ph	Short period
75	BU Cygni	20 02 41	+50 04.9	10.5<	15	ph	
76	BV Cygni	20 30 03	+53 56.8	11	12	ph	
77	BW Cygni	20 32 08	+58 25.1	12	14	ph	
78	BX Cygni	20 33 01	+60 58.8	12	13	ph	
79	BY Cygni	20 33 37	+54 18.0	14	<16	ph	
80	UU Cygni	20 36 54	+59 11.1	12.5	13.5	ph	
81	BZ Cygni	20 42 34	+44 56.5	11.2	12.3	ph	
82	CC Cygni	20 44 59	+53 40.5	11	<16	ph	

No.	Name	R.A.1900 h m s	Dec.1900 ° ′	Brightness Max.	Min.		Remarks
83	UV Cephei	20 49 16	+56 02.5	14	16	ph	
84	UW Cephei	20 56 51	+59 00.2	12.5	14	ph	
85	UX Cephei	21 01 01	+55 04.1	15	<16	ph	
86	UY Cephei	21 05 41	+58 21.5	12	16.5	ph	
87	CE Cygni	21 15 21	+46 35.1	9.2	10.8	ph	Irregular
88	VX Pegasi	21 38 09	+22 00.9	10.0	10.9	ph	
89	VY Pegasi	21 57 34	+ 1 55.5	11	<16	ph	
90	SW Lacertae	22 49 03	+37 23.4	8.6	...	v	Period $3^h\ 51^m$
91	SX Lacertae	22 51 19	+34 39.6	9.5	11.0	ph	
92	WY Andromedae	23 36 35	+47 02.5	10.3	11.4	ph	Short period
93	VZ Pegasi	23 37 14	+24 22.2	11.4	12.2	ph	
94	Nova Normae 2	15 32 01	−51 59.7	9	12.5	ph	
95	Nova Sagittarii 7	17 59 44	−31 44.9	8	<17	ph	
96	Nova Sagittarii 6	18 02 31	−32 29.1	7.1	<10	ph	

COMET AND ASTEROID NOTES.

New Comet *b* 1922 (Skjellerup).—A telegram received May 20 announces the discovery of a comet by Skjellerup at the Cape of Good Hope. Its position as observed on May 17 was

May 17.2500 R. A. $7^h\ 53^m\ 44^s$; Dec. +19° 32′.

Daily motion 4^m east, 48′ north. Nothing is stated as to its brightness in the announcement telegram.

A telegram received May 24 states that the comet was observed by Van Biesbroeck at the Yerkes Observatory on May 21 and that its magnitude was 13.

The following are all the observations which have come to hand:

Observations of Skjellerup's Comet *b* 1922.

Date G. M. T.	R. A. h m s	Dec. ° ′ ″	Observer	Place
May 17.2500	7 53 44	+19 32	Skjellerup	Cape
21.6357	8 15 56.2	+23 32 19	Van Biesbroeck	Williams Bay
25.7437	8 39 53.6	+27 49 22	Campbell and Scioberiti	Mt. Hamilton
31.7509	9 24 15.3	+34 48 52	Wilson	Northfield

The comet, when observed at Northfield on May 31, was very faint and diffuse, just visible in the 5-inch finder, about 2′ in diameter in the 16-inch telescope, with occasional flashes of a 13th magnitude nucleus and a slight condensation of the nebulosity around it. The comet is not one which will give much satisfaction to the amateur, unless it brightens very much before the time when the moon will again permit observations, in the latter half of June.

The course of the comet during the past two weeks has been northeasterly through the constellation Cancer, and if continued will carry it through the feet of Ursa Major into Canes Venatici, just below the handle of the Great Dipper, by the middle of June.

New Definitive Elements of the Jovian Planet (657) Nestor.—In "Publikationer og minder Meddelelser" of the Copenhagen Observatory, Mr. J. A. Kristensen gives new elements of the asteroid (659) Nestor, which is one of the group of minor planets which have been found to have almost the same mean distance and period as Jupiter. Mr. Kristensen has made use of all the available observations of the asteroid made in the years 1907-09 and 1917-1919,

and has made allowance for the perturbations by Jupiter and Saturn during the intervening years.

The definitive elements are as follows:

Epoch	1908 March 23.5 Berlin m. t.	
Osculation	1908 April 12.0 Berlin m. t.	
M	= 238° 18′ 00″.1	
ω	= 329 07 40.7	1910.0
Ω	= 350 01 28.7	1910.0
i	= 4 31 44.0	1910.0
ϕ	= 6 07 12.9	
μ	= 301″.21936	
log a	= 0.714083	

Elements of Reid's Comet *a* 1922 (1921 V).—In *The Observatory* for May 1922 we find the following elements of Reid's comet *a* 1922, calculated by Mr. H. E. Wood from observations at Johannesburg on January 23, 30, and February 5:

T	= 1921 Oct. 26.40738 G. M. T.	
ω	= 183° 31′ 09″.4	1922.0
Ω	= 275 06 26.8	1922.0
i	= 32 56 06.1	1922.0
log q	= 0.2183570	

$d\lambda \cos\beta = +9''.5$; $d\beta = -14''.2$.

Ephemeris of Comet 1909 IV (Daniel).

Date (GMT)		Right Ascension h m	Declination ° ′	
September	2.5	5 48	+15 15	
	7.5	6 7	15 45	
	12.5	6 23	16 41	
	17.5	6 39	17 36	
	22.5	6 57	18 30	
	27.5	7 14	19 17	
October	2.5	7 37	20 12	
	7.5	7 50	20 56	
	12.5	8 9	21 41	
	17.5	8 25	22 17	Perihelion
	22.5	8 41	22 54	
	27.5	8 59	23 32	
November	1.5	9 17	24 9	
	6.5	9 33	24 44	
	11.5	9 49	25 19	
	16.5	10 6	25 51	
	21.5	10 21	26 27	
	26.5	10 36	26 59	
December	1.5	10 42	+27 48	

CLAUDE H. HALL, JR.
E. LEE KINSEY.

April 22, 1922.
Maryland Academy of Sciences,
Baltimore, Maryland.

Monthly Report of the American Association of Variable Star Observers, March 20, to April 20, 1922.

Owing to an error on the part of the secretary the observations of Messrs. McAteer, Mundt and Yalden were omitted from the report last month, and they are included herewith. Several observers deserve special mention for their

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
	March 0 = J. D. 2423114						April 0 = J. D. 2423145					
001046 X ANDROMEDAE—												
	3108.5	11.0	M,	3136.6	12.8	Wf,	3143.7	12.9	Wf.			
001755 T CASSIOPEIAE—												
	3108.5	8.8	M,	3110.5	8.8	Ya,	3117.4	8.3	L,	3118.3	8.3	Gi,
	3130.3	8.3	An,	3130.4	8.3	L,	3130.6	7.9	B,	3132.3	8.4	Gi,
	3136.6	8.1	Pt,	3147.6	8.6	Ya.						
001838 R ANDROMEDAE—												
	3116.0	9.4	Ym,	3133.7	9.4	Br,	3136.5	9.5	Pt,	3136.7	9.2	Wf,
	3143.7	9.4	Wf.									
003179 Y CEPHEI—												
	3133.6	11.0	M.									
004047 U CASSIOPEIAE—												
	3129.7	14.3	Wf,	3136.7	<14.0	Wf,	3143.5	<12.8	Y,	3143.7	<14.0	Wf.
004533 RR ANDROMEDAE—												
	3136.7	10.4	Wf,	3150.0	<11.6	Wf.						
004746a RV CASSIOPEIAE—												
	3117.4	10.3	L,	3131.3	11.3	L,	3136.6	10.7	Pt.			
004958 W CASSIOPEIAE—												
	3108.5	8.7	M,	3110.5	8.4	Ya,	3118.3	8.3	Gi,	3130.6	8.6	B,
	3133.7	9.2	Br,	3136.6	9.0	Pt,	3147.6	9.0	Ya,	3160.6	<9.5	Cg.
010940 U ANDROMEDAE—												
	3136.7	13.2	Wf,	3143.7	13.1	Wf.						
011272 S CASSIOPEIAE—												
	3108.5	9.5	M,	3110.5	9.9	Ya,	3130.6	9.7	B,	3131.4	9.6	Rk,
	3136.6	10.5	Pt,	3136.7	9.4	Wf,	3143.4	9.7	Rk,	3147.6	10.6	Ya,
	3150.7	10.1	Wf.									
013238 RU ANDROMEDAE—												
	3130.5	10.7	B.	3136.7	10.4	Wf,	3143.7	10.2	Wf.			
014958 X CASSIOPEIAE—												
	3108.5	11.5	M,	3116.1	10.9	Ym,	3136.6	10.5	Pt,	3139.6	10.3	Y.
015354 U PERSEI—												
	3119.5	8.3	M,	3130.6	8.4	B,	3136.6	8.7	Pt,	3136.7	9.2	Mu.
021024 R ARIETIS												
	3119.3	10.7	L,	3125.7	9.7	Jb,	3130.3	10.0	L.			
021143a W ANDROMEDAE—												
	3129.7	13.1	Wf,	3136.7	13.2	Wf,	3150.7	13.2	Wf.			
021281 Z CEPHEI—												
	3130.6	<13.5	B.									
021403 o CETI—												
	3117.3	7.7	L,	3117.7	7.7	Jb,	3119.3	7.6	An,	3119.3	7.6	L,
	3126:3	6.7	L,	3131.3	6.4	L,	3136.5	5.7	Pt.			
021558 S PERSEI—												
	3119.5	9.2	M.									
022000 R CETI—												
	3108.9	<11.5	Kd.									
022150 RR PERSEI—												
	3136.6	9.7	Pt,	3153.7	9.9	Br.						
022980 RR CEPHEI—												
	3117.5	13.8	L,	3129.7	14.0	Wf,	3130.4	13.7	L,	3132.4	13.9	L,
	3136.7	13.9	Wf,	3143.5	<13.5	L,	3150.0	13.8	Wf,	3153.7	<10.9	Br.
023133 R TRIANGULI—												
	3106.9	7.9	Kd,	3108.5	7.8	M,	3108.9	7.9	Kd,	3120.5	8.2	Ya,
	3121.9	8.1	Kd,	3122.9	8.1	Kd,	3127.9	8.1	Kd,	3128.9	8.2	Kd,
	3130.6	8.4	B,	3136.6	8.6	Pt,	3137.4	8.5	Rk,	3141.6	9.1	Ya,
	3143.3	8.8	Rk.									
024356 W PERSEI—												
	3117.8	8.7	Jb,	3125.7	8.5	Jb,	3126.6	9.1	M,	3130.9	8.7	Ym,
	3133.7	8.6	Br.	3136.6	8.6	Pt,	3136.7	9.4	Mu,	3138.7	8.5	Jb,
	3139.0	8.8	Ym,	3146.6	9.4	M,	3146.7	8.6	Jb,	3147.8	8.6	Jb,
	3153.7	8.6	Br.									

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
030514 U ARIETIS—												
	3143.5	11.2	Y.									
031401 X CETI—												
	3118.3	9.2	L,	3127.3	9.5	L,	3136.5	9.1	Pt,	3136.6	9.6	Wf,
	3143.6	9.9	Wf.									
032043 Y PERSEI—												
	3126.6	10.0	M,	3132.5	9.7	B,	3136.6	9.8	Pt,	3136.7	9.9	Mu,
	3146.6	10.0	M.									
032335 R PERSEI—												
	3131.4	9.4	Gi,	3166.6	8.9	Pt.						
033362 U CAMELOPARDALIS—												
	3126.6	8.0	M.									
042209 R TAURI—												
	3135.6	13.8	B,	3159.6	<13.0	B.						
042215 W TAURI—												
	3117.7	10.2	Jb,	3126.6	10.5	M,	3133.7	11.4	Sg,	3135.7	11.4	Sg,
	3136.5	11.2	B,	3136.6	10.8	Pt,	3138.7	10.5	Jb,	3143.7	11.0	Sg,
	3154.7	<10.4	Sg,	3162.6	<10.4	Bh.						
042309 S TAURI—												
	3135.6	13.3	B,	3159.6	12.9	B.						
043065 T CAMELOPARDALIS—												
	3117.4	10.7	L,	3130.4	9.3	L,	3136.6	9.4	Pt.			
043208 RX TAURI—												
	3144.6	12.2	B.									
043274 X CAMELOPARDALIS—												
	3126.6	10.3	M,	3131.4	10.2	Rk,	3133.7	10.6	Y,	3136.6	11.3	Pt,
	3143.4	11.2	Rk,	3146.6	12.0	B,	3146.6	11.5	M.			
044617 V TAURI—												
	3129.7	13.1	Wf,	3135.5	13.3	B,	3136.7	13.2	Wf,	3140.7	13.2	Wf,
	3159.6	12.6	B.									
045307 R ORIONIS—												
	3117.3	12.7	Gi,	3135.6	13.0	B,	3137.6	12.1	Y,	3159.6	12.2	B.
045514 R LEPORIS—												
	3114.5	10.0	Ya,	3117.3	9.7	L,	3126.3	<10.1	L,	3130.3	9.8	L,
	3134.3	9.9	L,	3136.5	8.8	Pt,	3137.4	8.8	Rk,	3137.6	8.9	B,
	3143.3	8.5	Rk.									
050003 V ORIONIS—												
	3114.5	11.0	Ya,	3117.7	12.5	Jb,	3136.6	12.8	Pt,	3137.6	13.0	B,
	3137.6	12.8	Y.									
050022 T LEPORIS—												
	3114.5	8.6	Ya,	3136.5	9.5	Pt,	3158.6	10.3	B.			
050953 R AURIGAE—												
	3139.7	<12.1	Br,	3142.6	<12.8	Lv,	3153.7	<10.9	Br.			
051533 T COLUMBAE—												
	3141.6	<10.5	Bh.									
052034 S AURIGAE—												
	3117.5	10.0	Ya,	3118.4	9.2	L,	3126.6	10.4	M,	3130.4	9.9	L,
	3136.6	9.3	Pt,	3144.6	9.5	B,	3146.6	10.3	M.			
052036 W AURIGAE—												
	3118.4	12.2	L,	3130.3	10.8	L,	3130.6	10.6	B,	3131.4	10.4	Gi,
	3148.6	9.7	B,	3160.7	9.1	Pt.						
052404 S ORIONIS—												
	3135.6	13.2	B,	3138.7	<11.5	Jb,	3159.6	11.9	B.			
053005a T ORIONIS—												
	3114.5	10.7	Ya,	3117.3	9.8	L,	3117.7	10.8	Jb,	3118.3	10.4	An,
	3118.3	9.8	L,	3119.3	9.9	L,	3121.4	10.0	L,	3125.7	10.7	Jb,
	3126.3	10.4	L,	3130.3	10.1	L,	3130.3	10.3	An,	3131.3	10.3	An,
	3131.3	10.3	L,	3136.5	11.1	B,	3136.6	10.6	Pt,	3138.7	10.1	Jb,
	3143.3	10.3	L,	3160.6	10.8	Pt,	3160.6	11.0	B,	3161.5	10.6	Gd.
053068 S CAMELOPARDALIS—												
	3117.5	8.5	Ya,	3136.6	8.6	Pt,	3146.6	9.3	M.			

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
053326 RR TAURI—												
	3144.6	13.5	B.									
053531 U AURIGAE—												
	3137.6	12.8	B,	3158.6	10.6	Y,	3160.7	10.5	Pt,	3161.6	9.4	M.
054319 SU TAURI—												
	3116.1	9.4	Ym,	3117.4	9.5	L,	3118.4	9.4	L,	3118.4	9.8	An,
	3119.3	9.5	L,	3125.0	9.9	Ym,	3126.3	9.4	L,	3126.6	9.5	M,
	3126.7	9.4	Wf,	3127.4	9.4	Rk,	3129.7	9.4	Wf,	3130.3	9.5	L,
	3130.3	9.7	An,	3131.0	9.9	Ym,	3131.3	9.8	An,	3133.3	9.5	Dp,
	3133.3	9.4	Jp,	3133.8	9.4	Wf,	3136.4	9.5	Rk,	3136.6	9.5	Pt,
	3136.7	9.5	Wf,	3137.6	9.7	Y,	3139.0	9.4	Ym,	3139.3	9.5	Jp,
	3139.5	9.8	Pt,	3139.6	9.8	Y,	3139.6	9.6	Pc,	3139.7	9.4	Wf,
	3139.7	9.5	Br,	3140.7	9.5	Wf,	3142.6	9.5	Pt,	3143.3	9.5	Rk,
	3145.7	9.4	Wf,	3146.6	9.5	B,	3146.7	9.6	Pt,	3150.7	9.4	Wf,
	3151.6	9.6	Pt,	3151.6	9.6	B,	3152.6	9.5	Pc,	3153.7	9.4	Br,
	3157.6	9.5	Pc,	3157.6	9.6	B,	3160.6	9.5	Pt,	3160.6	9.5	Pc,
	3160.6	9.5	B,	3162.6	9.5	Bh,	3162.6	9.6	Pt,	3163.6	9.7	Pt.
054615a Z TAURI—												
	3133.3	11.0	Jp,	3133.3	10.8	Dp,	3139.3	11.0	Jp,	3139.6	12 7	Y.
054615b RS TAURI—												
	3139.6	9.1	Y.									
054615c RU TAURI—												
	3133.3	13.0	Jp,	3133.3	12.9	Dp,	3139.3	13.0	Jp.			
054920a U ORIONIS—												
	3116.0	11.8	Ym,	3125.0	12.3	Ym,	3130.6	12.1	B,	3131.0	12.3	Ym,
	3136.6	11.8	Pt,	3138.6	12.1	Jb,	3139.0	12.3	Ym,	3142.6	12.5	Lv,
	1351.6	11.5	B.									
054920b UW ORIONIS—												
	3142.6	10.8	Lv.									
054974 V CAMELOPARDALIS—												
	3130.6	13.9	B,	3133.8	13.5	Wf,	3140.8	13.8	Wf,	3150.0	14.0	Wf,
	3153.7<11.3		Br,	3158.6<13.5		B.						
055353 Z AURIGAE—												
	3126.6	10.5	M,	3129.7	9.5	Wf,	3130.6	9.6	B,	3136.6	9.6	Pt,
	3136.7	9.5	Wf,	3139.7	9.5	Br,	3146.6	9.4	M,	3148.6	9.5	B,
	3149.9	9.4	Wf,	3153.7	9.5	Br.						
060450 X AURIGAE—												
	3116.1	8.9	Ym,	3119.4	9.0	Ro,	3136.4	8.8	Ro,	3136.6	8.7	Pt,
	3137.6	8.7	B,	3148.4	9.0	Ro,	3154.6	9.4	M,	3156.4	9.1	Ro,
	3158.4	9.2	Ro,	3160.7	9.7	Mc,	3161.6	9.0	Hu.			
060547 SS AURIGAE—												
	3108.7<12.4		M,	3116.0<13.9		Ym,	3116.7<13.3		L,	3117.3	13.7	L,
	3117.4	13.4	Gi,	3117.4	13.5	L,	3117.5	13.0	L,	3117.6	12.8	L,
	3118.3	11.1	L,	3118.3	10.9	An,	3118.4	11.3	Gi,	3119.3	11.0	L,
	3119.6	11.1	L,	3120.3	10.9	L,	3120.4	11.3	Gi,	3120.5	11.1	Ya,
	3120.8	10.8	M,	3122.5	10.9	Ya,	3125.0	10.7	Ym,	3125.4	11.3	Gi,
	3126.3	11.1	L.	3126.5	11.2	Ya,	3126.6	11.4	M,	3127.3	11.3	L,
	3127.3	11.6	Gi,	3130.3	13.4	L,	3130.9	13.5	Ym,	3131.3	14.1	L,
	3131.4	13.9	Gi,	3131.4<12.4		Rk,	3131.6<11.4		Ya,	3131.7<13.6		B,
	3132.4<13.9		Gi,	3132.4	14.4	L,	3133.6<12.4		M.	3134.3<13.0		Jp,
	3134.3<13.0		Dp,	3134.4	14.7	L,	3136.4<12.4		Rk,	3136.6<12.6		Pt,
	3137.4<12.4		Rk,	3138.3<13.3		Jp,	3138.3<13.3		Dp,	3139.3<13.3		Jp,
	3139.5<12.4		Pt,	3139.6	13.8	Pc,	3139.7<12.5		Br,	3140.3<13.3		Jp,
	3140.3<13.3		Dp,	3141.4<12.4		Rk,	3142.6<12.6		Pt,	3143.3	14.7	L,
	3143.4<12.4		Rk,	3145.3<12.4		Rk,	3146.6<12.4		M,	3146.7<12.6		Pt,
	3151.6<11.0		Pt,	3153.7<11.6		Br,	3157.6<13.5		Pc,	3158.6<13.0		Y,
	3160.6	14.1	Pc,	3160.6<13.8		B,	3160.7<12.6		Pt,	3161.6<12.4		M,
	3162.6<12.6		Pt,	3163.6<12.6		Pt.						
061647 V AURIGAE—												
	3130.6	12.1	B,	3151.6	12.0	B,	3154.6	11.5	M.			

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
061702 V MONOCEROTIS—												
	3136.6	11.4	Pt.									
063159 U LYNCIS—												
	3131.6	<14.0	B,	3133.7	<13.1	Y,	3158.6	<13.9	B.			
063308 R MONOCEROTIS—												
	3136.6	11.6	B,	3136.6	12.0	Pt,	3139.8	<11.8	Br,	3153.7	<11.0	Br.
063558 S LYNCIS—												
	3130.6	13.8	B,	3139.8	<11.9	Br,	3153.7	<11.7	Br,	3158.6	<13.5	B.
064030 X GEMINORUM—												
	3117.4	10.8	Gi,	3132.4	10.1	Gi,	3144.6	9.6	B,	3161.6	9.4	M.
064707 W MONOCEROTIS—												
	3136.6	9.8	Pt.	3137.7	9.8	B,	3157.6	9.7	B.			
064932 NOVA GEMINORUM #2—												
	3117.5	14.1	L,	3131.3	13.9	L.						
065111 Y MONOCEROTIS—												
	3119.5	9.1	Ya,	3134.3	10.2	Jp,	3134.3	10.1	Dp,	3138.3	10.3	Jp,
	3138.3	10.4	Dp,	3139.3	10.2	Jp,	3139.6	10.6	Y,	3142.6	10.5	Lv,
	3147.7	10.4	B,	3158.6	11.4	Y.						
065208 X MONOCEROTIS—												
	3114.5	8.0	Ya,	3117.5	7.7	L,	3126.3	7.9	L,	3134.3	7.6	Jp,
	3134.3	7.7	Dp,	3138.3	7.6	Jp,	3138.3	7.7	Dp,	3139.3	7.6	Jp.
065355 R LYNCIS—												
	3131.4	10.5	Gi,	3133.8	10.5	Wf,	3140.8	10.4	Wf,	3144.6	10.0	B,
	3146.6	10.4	M,	3149.9	10.3	Wf.						
070109 V CANIS MINORIS—												
	3108.7	<10.9	M,	3134.4	<13.0	Jp,	3134.4	<13.0	Dp,	3137.7	<13.3	B,
	3139.4	<13.9	Jp,	3145.6	<13.4	B,	3157.6	<12.8	B.			
070122a R GEMINORUM—												
	3135.6	10.1	B,	3136.7	10.5	Pt,	3142.6	10.6	Lv,	3146.6	11.0	M,
	3148.6	10.6	Lv,	3159.6	11.4	B,	3161.6	11.0	Hu.			
070122b Z GEMINORUM—												
	3135.6	12.4	B,	3136.7	12.5	Pt,	3148.6	12.5	Lv,	3159.6	11.3	B.
070122c TW GEMINORUM—												
	3135.6	8.2	B,	3142.6	8.4	Lv,	3146.6	8.1	M,	3148.6	8.3	Lv,
	3159.6	8.3	B.									
070310 R CANIS MINORIS—												
	3117.4	8.5	L,	3120.5	8.9	Ya,	3127.3	9.0	L,	3127.3	9.0	An,
	3143.3	9.1	L,	3145.6	8.8	B.						
071044 L[3] PUPPIS—												
	3141.6	4.3	Bh.									
071201 RR MONOCEROTIS—												
	3148.6	<13.0	Lv.									
071713 V GEMINORUM—												
	3135.6	12.3	B,	3159.6	10.5	B,	3160.7	11.0	Pt,	3161.6	10.4	M.
072708 S CANIS MINORIS—												
	3117.4	10.9	L,	3119.4	10.2	Ro,	3127.4	10.3	L,	3131.4	9.9	Rk,
	3131.6	10.2	Ya,	3134.4	9.8	Dp,	3134.4	9.9	Jp,	3136.7	10.1	Pt,
	3136.4	9.9	Ro,	3136.6	10.3	Pc,	3137.6	9.8	B,	3139.4	9.9	Jp,
	3139.8	10.2	Br,	3143.3	10.1	L,	3143.3	9.8	Rk,	3146.6	10.2	M,
	3146.7	10.2	Jb,	3153.8	9.6	Br,	3157.6	9.4	Pc,	3158.4	10.0	Ro,
	3160.5	9.4	Ya,	3160.6	9.7	Su,	3162.6	9.7	Bh.			
072811 T CANIS MINORIS—												
	3106.9	9.9	Kd,	3108.7	9.7	,M	3108.9	10.0	Kd,	3130.9	11.0	Kd,
	3133.0	11.4	Kd,	3134.4	11.0	Jp,	3134.4	11.1	Dp,	3136.7	10.4	Pt,
	3139.4	11.0	Jp,	3145.7	11.7	B,	3146.6	12.0	M.			
072820b Z PUPPIS—												
	3139.7	<11.5	Br.									
073508 U CANIS MINORIS—												
	3108.7	11.0	M,	3117.5	11.1	L,	3127.4	11.6	L,	3136.7	12.0	Pt,
	3143.3	12.3	L,	3144.6	12.3	B,	3146.6	11.6	M,	3158.6	12.4	Y.

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
073723 S GEMINORUM—												
	3108.9	10.0	Kd,	3122.9	11.0	Kd,	3126.6	11.0	M,	3128.9	11.7	Kd,
	3134.4	11.4	Jp,	3134.4	11.4	Dp,	3136.7	12.0	Pt.	3137.7	11.8	B,
	3139.4	11.7	Jp.									
074323 T GEMINORUM—												
	3108.9	8.9	Kd,	3119.6	9.1	Ya,	3122.9	9.2	Kd,	3126.6	9.6	M,
	3127.9	9.3	Kd,	3128.9	9.4	Kd,	3130.9	9.5	Kd,	3134.4	9.5	Jp,
	3134.4	9.6	Dp,	3137.6	9.4	B,	3139.4	9.5	Jp.			
074922 U GEMINORUM—												
	3116.0	<13.7	Ym,	3117.4	14.1	L,	3117.4	14.1	Gi,	3118.3	14.1	L,
	3118.4	14.0	Gi,	3119.3	<14.0	L,	3119.6	<11.4	Ya,	3120.3	<13.3	L,
	3120.4	<13.7	Gi,	3125.0	<12.4	Ym,	3125.4	<12.9	Gi,	3125.4	< 9.3	Rk,
	3126.3	<10.0	L,	3126.7	<13.3	Wf,	3127.3	<13.3	Gi,	3127.4	<12.4	L,
	3127.4	<11.7	Rk,	3129.7	13.8	Wf,	3130.3	14.1	L,	3130.6	<13.7	B,
	3131.3	14.0	L,	3131.4	14.0	Gi,	3131.4	<12.4	Rk,	3131.7	14.0	B,
	3132.4	14.0	L,	3132.4	14.0	Gi,	3133.8	14.1	Wf,	3134.3	14.1	L,
	3134.4	<13.3	Jp,	3134.4	<13.3	Dp,	3134.7	14.0	B,	3136.4	<12.4	Rk,
	3136.7	14.0	Wf,	3136.7	<13.3	Pt,	3137.4	<12.4	Rk,	3137.7	<13.8	B,
	3138.4	<13.3	Jp,	3138.4	<13.3	Dp,	3138.7	14.0	Wf,	3139.0	<13.7	Ym,
	3139.4	<13.3	Jp,	3139.5	<12.4	Pt,	3139.6	<13.3	Y,	3139.6	13.9	Pc,
	3139.7	<12.4	Br,	3139.7	13.9	Wf,	3140.4	<13.3	Dp,	3140.4	<13.3	Jp,
	3140.7	14.1	Wf,	3141.4	<11.8	Rk,	3142.0	<12.4	Ym,	3142.6	<13.3	Pt,
	3143.3	14.2	L,	3143.3	<12.4	Rk,	3145.3	<12.4	Rk,	3145.6	<13.8	B,
	3145.7	13.7	Wf,	3146.6	<12.4	M,	3146.7	<13.3	Pt,	3149.9	13.7	Wf,
	3150.7	13.7	Wf,	3152.6	<11.7	B,	3153.7	<10.9	Br,	3154.6	<11.4	M,
	3157.6	<13.7	B,	3157.6	<13.8	Pc,	3158.6	<13.8	B,	3158.6	<13.3	Y,
	3159.6	<13.7	B,	3160.6	14.0	Pc,	3160.6	14.0	B,	3160.7	<13.3	Pt,
	3163.6	<12.4	Pt.									
075612 U PUPPIS—												
	3135.6	<13.0	B,	3159.6	<13.5	B.						
081112 R CANCRI—												
	3119.3	7.4	L,	3130.4	7.0	L,	3131.4	7.0	Rk,	3132.6	6.5	Ya,
	3136.7	6.5	Pt,	3143.3	7.0	Rk,	3146.6	7.0	B,	3147.6	7.0	M,
	3160.6	7.8	Cg,	3161.5	8.1	Gd,	3161.6	7.9	Ya.			
081617 V CANCRI—												
	3117.4	8.5	Gi,	3119.5	9.0	M,	3132.4	8.9	Gi,	3132.6	9.1	B,
	3136.7	9.0	Pt,	3138.7	9.2	Br,	3147.6	10.0	M,	3153.8	10.3	Br,
	3159.6	10.4	B.									
081633 T LYNCIS—												
	3143.6	10.6	Hu.									
082405 RT HYDRAE—												
	3117.5	8.0	L,	3130.4	8.0	L,	3134.4	8.2	Jp,	3134.4	8.0	Dp,
	3136.6	8.1	B,	3136.7	7.9	Pt,	3138.4	8.0	Jp,	3138.4	8.0	Dp,
	3139.4	8.2	Jp,	3160.5	7.8	Ya.						
083019 U CANCRI—												
	3133.8	13.9	Wf,	3134.4	<13.3	Dp,	3134.4	<13.3	Jp,	3138.4	<13.3	Jp,
	3138.4	<13.3	Dp,	3139.4	<13.3	Jp,	3140.8	13.8	Wf,	3149.9	13.9	Wf,
	3161.6	12.4	M.									
083350 X URSAE MAJORIS—												
	3130.6	14.0	B.									
084803 S HYDRAE—												
	3116.0	10.6	Ym,	3119.6	10.2	Ya,	3136.6	8.8	B.	3136.7	9.1	Pt.
	3139.8	8.7	Br,	3140.4	9.0	Jp.	3140.4	8.8	Dp,	3143.4	8.6	Rk,
	3143.6	8.3	Hu,	3147.6	9.0	M,	3153.8	8.2	Br,	3159.6	8.1	B,
	3161.5	8.4	Gd.	3166.6	7.5	Hu.						
085008 T HYDRAE—												
	3117.5	9.2	L,	3130.4	8.4	L,	3136.6	8.2	B.	3136.7	8.4	Pt,
	3139.8	8.4	Br,	3145.3	9.7	Rk,	3153.8	7.5	Br,	3161.5	7.4	Ya,
	3161.6	8.0	M.									

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
085120 T CANCRI—												
	3117.5	8.6	L,	3119.5	9.4	M,	3130.4	8.5	L,	3136.7	8.3	Pt,
	3147.6	9.0	M.									
090024 S PYXIDIS—												
	3123.0	9.8	Kd,	3127.9	9.2	Kd,	3128.9	9.1	Kd,	3130.9	9.3	Kd,
	3133.0	9.4	Kd,	3136.7	8.3	Pt.						
090151 V URSAE MAJORIS—												
	3157.6	10.3	B,	3161.6	10.0	Hu.						
090425 W CANCRI—												
	3118.4	12.0	L,	3130.4	12.1	L,	3131.6	12.3	B,	3133.8	12.7	Wf,
	3140.8	12.4	Wf,	3149.9	12.8	Wf.						
093014 X HYDRAE—												
	3113.7	11.2	Mu,	3131.6	11.8	B,	3136.7	11.9	Pt,	3151.6	12.2	B.
093178 Y DRACONIS—												
	3133.7	13.9	Y.									
093934 R LEONIS MINORIS—												
	3116.1	8.0	Ym,	3117.4	7.2	L,	3118.4	7.3	An,	3130.4	7.2	L,
	3132.6	7.4	Ya,	3132.6	7.4	B,	3136.6	7.5	Pc,	3136.7	7.3	Pt,
	3140.4	7.4	Jp,	3140.4	7.5	Dp,	3143.6	7.5	Hu,	3147.6	8.3	M,
	3153.6	7.9	B,	3160.6	7.9	Pc,	3161.6	8.5	Ya.			
094211 R LEONIS—												
	3113.6	8.7	Mu,	3116.0	9.1	Ym,	3119.4	8.8	Ro,	3119.5	8.2	M,
	3120.6	8.3	Ya,	3130.3	9.1	An,	3135.6	8.7	Pw,	3136.4	9.5	Ro,
	3136.4	8.4	Rk,	3136.6	8.9	Pc,	3136.7	8.4	Pt,	3138.7	9.2	Br,
	3140.4	8.3	Jp,	3140.4	8.4	Dp,	3142.0	9.0	Ym,	3143.0	9.1	Ym,
	3143.4	8.7	Rk,	3143.6	8.8	Pw,	3143.7	8.9	Mc,	3147.6	9.3	M,
	3148.4	9.3	Ro,	3154.7	8.9	Sg,	3156.4	9.8	Ro,	3157.6	8.7	Pc,
	3158.4	9.6	Ro,	3160.6	10.2	Su,	3160.6	8.9	Pc,	3160.6	9.9	Cg,
	3161.6	9.0	Ya,	3162.4	10.0	Ro.						
094512 X LEONIS—												
	3116.0	<13.0	Ym,	3117.4	<14.0	L,	3118.3	<13.3	L,	3119.6	<13.3	L,
	3120.6	<13.3	L,	3130.3	12.0	L,	3130.3	11.8	An,	3131.3	11.8	L,
	3131.3	11.8	An,	3132.4	11.7	L,	3134.3	12.7	L,	3142.0	12.8	Ym,
	3143.0	11.8	Ym,	3143.3	<13.3	L.						
094622 Y HYDRAE—												
	3119.6	7.0	Ya,	3136.7	6.4	Pt,	3140.4	7.0	Jp,	3140.4	7.0	Dp.
095421 V LEONIS—												
	3131.6	12.5	B,	3133.8	12.9	Wf,	3136.7	12.9	Pt,	3140 8	13.2	Wf,
	3148.7	13.3	Lv,	3149.9	13.3	Wf,	3156.6	13.1	Lv.			
103212 U HYDRAE—												
	3119.6	5.1	L,	3131.3	4.8	L,	3162.6	5.2	Bh.			
103769 R URSAE MAJORIS—												
	3108.7	<11.5	M,	3131.6	12.9	B,	3139.6	13.1	Pc,	3143.6	11.1	Pw,
	3147.6	11.4	M,	3151.6	13.0	B,	3154.6	10 8	M,	3158.6	13.0	Pc,
	3160.7	13.2	Pt.									
104620 V HYDRAE—												
	3136.7	7.6	Pt.									
104814 W LEONIS—												
	3139.6	10.2	Pt,	3140.4	10.3	Dp,	3140.4	10.4	Jp,	3143.7	10.4	Y,
	3148.6	10.3	B,	3161.6	11.5	M.						
110506 S LEONIS—												
	3136.6	10.5	B,	3139.6	11.8	Pt.						
115919 R COMAE BERENICES—												
	3133.8	13.8	Wf,	3139.8	<11.8	Br,	3140.8	13.9	Wf,	3149.9	13.6	Wf,
	3156.6	<12.5	Lv,	3161.6	12.5	M.						
120012 SU VIRGINIS—												
	3135.6	8.6	Pw,	3139.6	11.5	Pt,	3146.6	11.9	B,	3147.6	12.2	M.
120905 T VIRGINIS—												
	3135.6	<10.0	Pw,	3139.8	<11.1	Br,	3145.7	<13.5	B,	3153.8	<10.6	Br.

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
121418 R CORVI—												
	3119.6	9.6	L,	3131.6	8.5	L,	3134.6	8.1	B,	3142.0	8.1	Ym,
	3143.0	8.0	Ym,	3146.8	7.0	Pt,	3147.6	7.6	M,	3160.7	7.9	B.
122001 SS VIRGINIS—												
	3119.6	8.1	L,	3130.4	7.9	L,	3134.6	8.2	B,	3147.6	9.5	M,
	3160.6	8.5	B.									
122532 T CANUM VENATICORUM—												
	3136.6	11.7	B,	3139.6	11.5	Pt,	3139.8	11.5	Br,	3146.7	12.0	M,
	3153.8<10.6		Br.									
122803 Y VIRGINIS—												
	3117.5	9.9	L,	3132.6	10.6	L,	3139.8	11.2	Br,	3146.7	10.6	M.
123160 T URSAE MAJORIS—												
	3108.7	11.0	M,	3113.6	10.1	Mu,	3116.0	11.5	Ym,	3136.6	12.1	B,
	3139.6	12.4	Pc,	3139.6	12.0	Pt,	3139.8<12.4		Br,	3146.6	12.6	B.
	3147.6	12.2	M,	3147.6	12.6	Hu,	3153.8<10.9		Br,	3160.6	12.9	Pc.
123307 R VIRGINIS—												
	3117.5	10.4	L,	3132.6	11.4	L,	3134.6	11.3	B,	3139.0	11.3	Ym,
	3139.6	11.3	Pt,	3142.0	11.5	Ym,	3146.7	10.7	M,	3160.6	10.7	B.
123459 RS URSAE MAJORIS—												
	3108.7	11.4	M,	3113.6<10.9		Mu,	3116.0<12.6		Ym,	3129.7	12.9	Wf,
	3136.4	10.0	Ro,	3136.7	12.4	Wf,	3136.7	10.9	Mu,	3139.6	11.6	Pt,
	3139.6	12.1	Pc,	3139.8	12.0	Br,	3142.0	12.2	Ym,	3145.7	11.3	Wf,
	3146.7	11.7	B,	3147.6	11.4	M,	3153.8	11.0	Br,	3154.6	10.5	M,
	3160.6	10.4	Pc,	3161.7	10.3	Su.						
123961 S URSAE MAJORIS—												
	3108.7	8.6	M,	3113.6	8.6	Mu,	3118.4	8.1	L,	3118.4	8.2	An,
	3119.4	8.6	Ro,	3127.3	8.3	An,	3130.4	8.2	An,	3130.4	7.4	L,
	3130.8	7.5	Sg,	3132.7	7.5	Sg,	3133.7	8.5	Sg,	3135.7	7.3	Sg,
	3136.4	7.4	Ro,	3136.6	7.6	Pc,	3136.7	8.3	Mu,	3139.6	7.5	Pt,
	3139.8	7.6	Br,	3143.8	8.5	Sg,	3146.7	7.7	B,	3147.6	8.0	M,
	3147.6	7.9	Hu,	3147.7	8.0	Mc,	3148.4	7.7	Ro,	3149.9	7.3	Sg,
	3151.6	8.1	Pc,	3153.8	8.0	Br,	3154.6	8.2	M,	3156.4	8.0	Ro,
	3157.7	7.9	Sg,	3158.4	8.1	Ro,	3158.6	8.7	Pc,	3161.7	8.5	Su,
	3162.4	8.1	Ro.									
124606 U VIRGINIS—												
	3134.7	11.8	B,	3160.6	12.6	B.						
130212 RV VIRGINIS—												
	3133.8	14.5	Wf,	3140.9<14.0		Wf,	3149.9<14.0		Wf.			
132422 R HYDRAE—												
	3119.6	6.4	L,	3119.6	6.1	L,	3119.6	5.7	L,	3131.6	6.4	L,
	3131.6	6.3	L,	3134.1	6.9	Kd,	3146.8	6.5	Pt,	3142.0	7.7	Ym.
132706 S VIRGINIS—												
	3116.2	7.7	Ym,	3125.7	8.0	Jb.	3129.0	8.0	Ym,	3133.8	7.4	Wf,
	3138.7	8.1	Jb,	3138.8	7.9	Sg,	3139.7	7.7	Pt.	3140.9	7.9	Wf,
	3142.0	8.2	Ym,	3143.8	8.3	Sg,	3146.6	8.1	B,	3146.7	8.3	M,
	3149.9	8.2	Wf,	3150.7	8.2	Sg,	3157.7	8.4	Sg.			
133273 T URSAE MINORIS—												
	3129.7	13.5	Wf,	3136.7	14.0	Wf,	3145.7	12.7	Wf.			
133633 T CENTAURI—												
	3162.6	6.6	Bh.									
134440 R CANUM VENATICORUM—												
	3136.7	8.3	B,	3139.7	8.2	Pt,	3146.7	8.0	M,	3147.6	8.0	Hu,
	3148.4	8.1	Ro.									
135908 RR VIRGINIS—												
	3146.8	11.6	Pt.									
140113 Z BOOTIS—												
	3120.8	9.5	M,	3133.8	9.7	Wf,	3137.6	9.9	Y,	3139.7	10.3	Pt,
	3140.9	10.0	Wf,	3146.7	10.2	M,	3149.9	10.2	Wf,	3158.6	10.8	B.
	3161.6	11.0	M.									
141567 U URSAE MINORIS—												
	3135.6	8.7	Pw,	3136.6	8.9	Pc,	3143.6	8.3	Pw,	3146.7	8.4	M,

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
141567 U URSAE MINORIS—Continued.												
	3160.6	7.9	Pc,	3160.6	8.1	Pw,	3160.7	7.7	Pt,	3160.7	8 0	Mc,
	3161.6	8.5	M.									
141954 S BOOTIS—												
	3116.0	12.5	Ym,	3118.4	12.7	L,	3131.3	12 9	L,	3131.4	12.8	Gi,
	3137.6	12.5	Y,	3142.0	<12.0	Ym,	3160.6	<11.0	Pw,	3160.7	12.4	Pt.
142205 RS VIRGINIS—												
	3146.7	7.8	M,	3161.6	7.9	M.						
142539 V BOOTIS—												
	3119.4	8.3	Ro,	3119.7	7.4	L,	3130.8	7.4	Sg,	3131.4	7.2	L,
	3136.6	7.0	Pc,	3138.8	7.5	Sg,	3143.7	7.3	Mc,	3145.8	7.0	Sg,
	3146.7	7.4	M,	3146.8	6.8	Pt,	3147.7	7.5	Mc,	3148.4	7.4	Ro,
	3150.7	6 8	Sg,	3151.6	7.1	Pc,	3156.4	7.5	Ro,	3158.4	7.5	Ro,
	3159.7	7.0	Sg,	3160.6	7.3	Pc,	3160.6	7.7	Su,	3162.4	7.5	Ro,
	3162.6	7.5	Bh.									
142584 R CAMELOPARDALIS—												
	3118.3	10.8	Gi,	3129.7	10.3	Wf,	3136.7	10.0	Wf,	3139.8	9.8	Br,
	3145.7	9.9	Wf,	3153.8	9.9	Br,	3154.6	9.5	M,	3160.7	9.2	Pt,
	3161.6	9.3	M.									
143227 R BOOTIS—												
	3130.8	11.1	Sg,	3133.7	<10.5	Sg,	3135.7	<10.5	Sg,	3138.8	11.0	Sg,
	3139.9	11.5	Br,	3143.7	< 9.2	Mc,	3143.8	11.0	Sg,	3146.7	11.3	M,
	3146.8	11.8	Pt,	3149.8	11.5	Sg,	3153.8	<10.9	Br,	3158.7	12.1	B,
	3159.8	11.5	Sg,	3160.6	11.5	Su,	3162.6	10.9	Bh.			
143417 V LIBRAE—												
	3153.8	10.2	Br.									
144918 U BOOTIS—												
	3120.8	10.3	M,	3131.5	10.7	Gi,	3146.7	11.4	M,	3158.6	11.7	B,
	3161.6	11.6	M.									
150018 RT LIBRAE—												
	3146.8	9.1	Pt.									
150605 Y LIBRAE—												
	3116.7	8.8	L,	3131.7	9.5	L,	3146.8	10.2	Pt,	3161.7	11.4	M.
151520 S LIBRAE—												
	3116.7	10.2	L,	3131.7	9.4	L,	3146.8	8.6	Pt.			
151714 S SERPENTIS—												
	3119.7	14.0	L,	3132.4	12.7	L,	3133.8	13.3	Wf,	3140.9	13.5	Wf,
	3149.9	13.2	Wf.									
151731 S CORONAE BOREALIS—												
	3133.8	8.8	Wf,	3139.9	9.6	Br,	3140.9	8.9	Wf,	3146.7	10.0	M,
	3146.8	9.8	Pt,	3149.9	9.6	Wf,	3153.8	9.7	Br,	3154.7	10.0	Sg,
	3157.6	9.6	Pc,	3160.6	10.3	Su,	3160.6	9.7	Pc,	3160.7	<8.5	Mc.
151822 RS LIBRAE—												
	3116.7	10.9	L,	3131.7	10.0	L.						
152714 RU LIBRAE—												
	3119.6	13.4	L,	3143.6	12.6	L,	3146.8	12.0	Pt.			
153215 W LIBRAE—												
	3119.6	13.9	L.									
153378 S URSAE MINORIS—												
	3129.7	10.2	Wf,	3136.7	10.0	Wf,	3139.9	9.8	Br,	3140.8	11.2	M,
	3145.7	10.2	Wf,	3153.9	9.7	Br,	3160.6	10.5	Su,	3160.7	10.1	Pt.
154428 R CORONAE BOREALIS—												
	3116.6	6.3	L,	3117.7	6.3	Gi,	3119.6	6.7	L,	3120.6	6.2	L,
	3124.7	6.3	L,	3129.8	6.1	Wf,	3130.8	6.0	Sg,	3131.6	6.2	L,
	3132.4	6.2	L,	3132.8	6.8	Sg,	3133.8	6.1	Wf,	3135.7	6.5	Sg,
	3136.7	6.3	Pt,	3136.8	6.1	Wf,	3138.7	6.1	Mu,	3138.8	6.5	Sg,
	3138.8	6.2	Wf,	3139.6	6.5	Pc,	3139.7	6.1	Pt,	3140.9	6.2	Wf,
	3142.7	6.1	Pt,	3143.2	6.5	Ym,	3143.6	6.3	L,	3143.8	6.8	Sg,
	3145.8	6.2	Mu,	3145.8	6.8	Sg,	3146.7	6.2	Jb,	3146.7	6.2	Pt,
	3146.7	6.0	M,	3146.8	7.0	Sg,	3147.7	7.0	Sg,	3147.8	6.1	Pt,

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	J.D.	Est.Obs.	J.D.	Est.Obs.
154428 R CORONAE BOREALIS—Continued.								
	3149.9	6.8 Sg,	3149.9	6.4 Wf,	3150.7	6.5 Sg,	3152.6	6.4 Pc,
	3154.7	6.5 Sg,	3154.7	6.0 M,	3154.8	6.3 Pt,	3157.6	6.3 Pc,
	3157.8	6.1 Pt,	3159.7	6.0 Sg,	3160.6	6.3 Pc,	3160.6	7.0 Pw,
	3160.6	6.6 Su,	3160.7	6.1 Pt,	3161.6	6.1 Su,	3161.7	6.2 M,
	3162.6	6.9 Bh,	3162.7	6.1 Pt,	3163.7	6.1 Pt,	3164.8	6.2 Pt,
154536 X CORONAE BOREALIS—								
	3133.8	12.4 Wf,	3140.9	11.8 Wf,	3149.9	11.8 Wf.		
154615 R SERPENTIS—								
	3146.7	7.2 M,	3146.8	7.3 Pt,	3161.6	7.4 Su.		
154639 V CORONAE BOREALIS—								
	3133.8	8.2 Wf,	3139.9	9.2 Br,	3140.9	8.5 Wf,	3146.7	9.5 M,
	3146.8	8.3 Pt,	3149.9	8.6 Wf,	3153.9	9.0 Br.		
155018 RR LIBRAE—								
	3119.7	14.5 L,	3143.6	14.5 L.				
155823 RZ SCORPII—								
	3146.8	9.5 Pt.						
160021 Z SCORPII—								
	3119.7	10.9 L,	3132.7	11.3 L.				
160118 R HERCULIS—								
	3146.8	9.2 Pt.						
160210 U SERPENTIS—								
	3139.9	<11.4 Br,	3146.7	<11.4 M,	3146.8	12.5 Pt,	3153.9	<10.6 Br.
160625 RU HERCULIS—								
	3133.8	11.3 Wf,	3140.9	11.4 Wf,	3146.7	12.1 M,	3146.8	11.8 Pt,
	3149.9	11.6 Wf.						
161122b S SCORPII—								
	3146.8	10.9 Pt.						
161122c T SCORPII—								
	3146.8	10.9 Pt.						
161138 W CORONAE BOREALIS—								
	3133.8	12.4 Wf,	3139.9	<11.5 Br,	3140.9	12.4 Wf,	3146.7	<11.5 M,
	3146.8	12.1 Pt,	3149.9	11.9 Wf,	3153.9	<11.0 Br,	3157.6	11.4 Pc.
161607 W OPHIUCHI—								
	3119.7	10.2 L,	3132.7	9.7 L,	3146.8	9.8 Pt.		
162112 V OPHIUCHI—								
	3146.8	9.6 Pt,	3149.8	8.8 M.				
162119 U HERCULIS—								
	3133.9	8.4 Wf,	3139.9	8.5 Br,	3140 9	8.4 Wf,	3146.7	8.4 M,
	3146.8	8.4 Pt,	3149.9	8.8 Wf,	3153.9	9.0 Br,	3161.6	9.3 Su.
162807 SS HERCULIS—								
	3116.7	9.4 L,	3131.6	11.5 L,	3139.9	11.0 Br,	3146.8	11.6 Pt,
	3149.8	11.7 M,	3153.9	<10.9 Br.				
162815 T OPHIUCHI—								
	3120.7	11.6 L,	3132.7	10.4 L,	3146.8	9.8 Pt.		
162816 S OPHIUCHI—								
	3120.7	9.8 L,	3132.7	10.3 L.				
163137 W HERCULIS—								
	3139.9	9.4 Br,	3146.7	8.8 M,	3146.8	8.8 Pt,	3153.9	9.0 Br.
163172 R URSAE MINORIS—								
	3146.7	9.4 M.						
163266 R DRACONIS—								
	3136.6	8.3 Pc,	3137.6	8.1 Y,	3139.9	8.2 Br,	3146.7	7.6 M,
	3153.9	8.0 Br,	3163.6	8.0 Pt.				
164055 S DRACONIS—								
	3146.7	8.7 M.						
164319 RR OPHIUCHI—								
	3120.7	12.8 L,	3143.6	<12.0 L.				
164715 S HERCULIS—								
	3139.9	8.8 Br,	3146.7	9.8 M,	3146.8	9.3 Pt,	3153.9	9.9 Br.

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
165631 RV HERCULIS—												
	3146.7	12.0	M,	3146.8	12.5	Pt.						
170215 R OPHIUCHI—												
	3146.8	9.7	M,	3146.8	9.4	Pt.						
170627 RT HERCULIS—												
	3133.9	12.4	Wf,	3139.9	<12.2	Br,	3140.9	12.5	Wf,	3146.8	12.4	Pt,
	3149.8	12.0	M,	3149.9	12.5	Wf,	3153.9	<11.0	Br.			
171401 Z OPHIUCHI—												
	3140.0	8.7	Br,	3146.8	8.9	Pt,	3153.9	9.0	Br.			
171723 RS HERCULIS—												
	3133.9	9.3	Wf,	3140.0	9.0	Br,	3140.9	8.9	Wf,	3146 8	9.1	M,
	3146.8	9.0	Pt,	3149.9	8.8	Wf,	3153.9	8.8	Br.			
172809 RU OPHIUCHI—												
	3140.0	<11.8	Br,	3146.8	<11.8	M,	3146.8	11.0	Pt,	3153.9	<10.9	Br.
173212 RT SERPENTIS—												
	3120.7	9.6	L,	3132.6	9.4	L.						
174406 RS OPHIUCHI—												
	3164.8	10.9	Pt.									
175519 RY HERCULIS—												
	3140.0	11.0	Br,	3146.8	11.4	M,	3146.8	11.8	Pt,	3153.9	<11.0	Br.
180531 T HERCULIS—												
	3116.7	12.8	L,	3132.6	12.4	L,	3140.0	11.1	Br,	3146.8	11.4	Pt,
	3149.8	10.2	M,	3153.9	10.3	Br,	3161.6	9.5	Su.			
180565 W DRACONIS—												
	3146.7	<11.5	M,	3163.6	12.2	Pt.						
180666 X DRACONIS—												
	3146.7	10.8	M.									
181031 TV HERCULIS—												
	3119.7	13.5	L,	3132.6	13.7	L.						
181103 RY OPHIUCHI—												
	3133.9	11.8	Wf,	3140.0	<11.3	Br,	3141.0	12.2	Wf,	3146.8	13.0	Pt,
	3150.0	12.9	Wf.									
181136 W LYRAE—												
	3119.7	10.0	L,	3131.7	10.5	L,	3133.9	10.4	Wf,	3140.9	10.8	Wf,
	3146.8	11.8	Pt,	3149.8	12.2	M,	3149.9	12.1	Wf,	3161.6	<10.5	Su.
182224 SV HERCULIS—												
	3120.7	<14.1	L,	3143.6	13.7	L,	3164.8	12.6	Pt.			
182306 T SERPENTIS—												
	3146.9	11.2	Pt.									
183225 RZ HERCULIS—												
	3146.9	10.3	Pt.									
183308 X OPHIUCHI—												
	3119.7	7.2	L,	3132.7	6.7	L,	3146.9	6.1	Pt.			
184134 RY LYRAE—												
	3146.9	12.7	Pt.									
184205 R SCUTI—												
	3119.7	5.0	L,	3124.7	5.0	L,	3131.7	5.7	L,	3139.9	5.5	M,
	3143.7	6.2	L,	3146.9	6.4	Pt,	3164.8	6.5	Pt.			
184300 NOVA AQUILAE #3—												
	3116.3	9.9	Ym,	3120.7	9.9	L,	3146.9	10.0	Pt,	3164.8	9.8	Pt.
185512a ST SAGITTARII—												
	3120.7	10.0	L,	3124.7	10.1	L.						
185634 Z LYRAE—												
	3120.7	<14.8	L,	3154.0	<10.9	Br.						
185737 RT LYRAE—												
	3154.0	<11.0	Br.									
190108 R AQUILAE—												
	3146.9	11.3	Pt.									
190529a V LYRAE—												
	3163.7	9.1	Pt.									

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.Obs.	J.D.	Est.Obs.	J.D.	Est.Obs.	J.D.	Est.Obs.
190925 S LYRAE—								
	3120.7	14.5 L,	3143.6	13.8 L,	3146.8<11.6 M,		3164.8	11.8 Pt.
190926 X LYRAE—								
	3146.8	9.0 M,	3163.7	9.0 Pt.				
190967 U DRACONIS—								
	3154.0<10.9 Br,		3163.7	12.5 Pt.				
191019 R SAGITTARII—								
	3164.8	9.3 Pt.						
191033 RY SAGITTARII—								
	3131.7	8.0 L,	3143.7 <9.2 L,		3146.9<11.0 Pt,		3164.8<10.0 Pt.	
191350 TZ CYGNI—								
	3163.7	11.0 Pt.						
191637 U LYRAE—								
	3163.7	11.0 Pt.						
193449 R CYGNI—								
	3146.8	9.2 M,	3154.0	7.0 Br,	3163.7	7.4 Pt.		
193509 RV AQUILAE—								
	3154.0	8.7 Br.						
194048 RT CYGNI—								
	3146.8	9.5 M,	3163.7	10.6 Pt.				
194348 TU CYGNI—								
	3146.8<11.6 M.							
AAVSO—March April— FIVE—	(¦'!?ᗰ	?ᗰ	?ᗰ	?ᗰ	?7ᗰ	?ᗰ	?ᗰ	RKNEE
194604 X AQUILAE—								
	3134.0	9.8 Wf,	3141.0	10.2 Wf,	3150.0	10.9 Wf,	3164.8	11.8 Pt.
195653 NOVA CYGNI #3—								
	3116.3	9.8 Ym,	3136.7	9.7 Pt,	3146.9	10.0 Pt,	3160.7	9.8 Pt,
	3163.7	10.0 Pt,	3164.8	9.9 Pt.				
195849 Z CYGNI—								
	3133.9	13.7 Wf,	3136.8	13.8 Wf,	3141.0	13.8 Wf,	3150.0	13.6 Wf.
200212 SY AQUILAE—								
	3119.7	8.8 L,	3132.7	8.8 L,	3164.8	10.0 Pt.		
200357 S CYGNI—								
	3164.8	10.4 Pt.						
200715a S AQUILAE—								
	3133.9	9.4 Wf,	3141.0	10.2 Wf,	3150.0	10.3 Wf,	3164.8	9.6 Pt.
200938 RS CYGNI—								
	3119.7	7.5 L,	3132.7	7.5 L,	3163.8	8.1 Pt.		
201008 R DELPHINI—								
	3116.7	13.0 L,	3143.6	12.4 L.				
201647 U CYGNI—								
	3163.8	6.3 Pt.						
202817 Z DELPHINI—								
	3164.8	9.1 Pt.						
202946 SZ CYGNI—								
	3163.8	9.5 Pt.						
202954 ST CYGNI—								
	3139.9	10.0 M,	3164.8	10.9 Pt.				
203226 V VULPECULAE—								
	3164.8	8.5 Pt.						
204016 T DELPHINI—								
	3134.0	12.2 Wf,	3141.0	12.3 Wf,	3150.0	12.6 Wf.		
205923 R VULPECULAE—								
	3164.8	8.4 Pt.						
210868 T CEPHEI—								
	3101.7	7.4 Mu,	3113.6	7.3 Mu,	3114.7	7.4 Mu,	3115.7	7.4 Mu,
	3117.4	7.3 L,	3117.7	7.3 Mu,	3130.4	7.0 L,	3130.7	7.2 Mu,
	3133.7	7.2 Mu,	3135.7	7.2 Mu,	3136.7	7.2 Mu,	3138.7	7.1 Mu,
	3140.7	7.1 Mu,	3145.7	7.1 Mu,	3146.7	7.1 Mu,	3147.7	7.1 Mu,
	3160.6	6.5 Cg,	3163.7	6.0 Pt.				

VARIABLE STAR OBSERVATIONS, March 20 to April 20, 1922—Continued.

Star	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.	J.D.	Est.	Obs.
211614 X PEGASI—												
	3164.8	9.1	Pt.									
213244 W CYGNI—												
	3119.7	5.8	L,	3131.6	5.9	L.						
213678 S CEPHEI—												
	3163.7	9.7	Pt.									
213843 SS CYGNI—												
	3116.3	11.9	Ym,	3116.6	11.4	L,	3119.3	11.5	L,	3119.7	11.4	L,
	3120.7	11.6	L,	3124.7	11.8	L,	3131.6	11.1	L,	3132.6	11.1	L,
	3133.9	10.2	Wf,	3136.9	9.2	Wf,	3138.9	8.7	Wf,	3139.9	8.8	M,
	3140.9	8.9	Wf,	3143.6	9.4	L,	3146.9	11.8	Pt,	3150.0	11.5	Wf,
	3154.0<	10.9	Br,	3154.8<	10.2	Pt,	3157.8<	10.2	Pt,	3163.8	11.9	Pt,
	3164.8	11.8	Pt.									
213937 RV CYGNI—												
	3164.8	6.5	Pt.									
214024 RR PEGASI—												
	3164.8	11.5	Pt.									
220412 T PEGASI—												
	3143.7	10.7	L.									
222439 S LACERTAE—												
	3119.3	10.6	L,	3131.3	9.6	L,	3164.8	7.9	Pt.			
223841 R LACERTAE—												
	3143.6	13.5	L.									
230759 V CASSIOPEIAE—												
	3113.7	8.9	Mu,	3164.8	10.8	Pt.						
231425 W PEGASI—												
	3119.3	8.3	L,	3131.7	8.6	L.						
233335 ST ANDROMEDAE—												
	3115.9	9.6	Ym,	3136.6	9.1	Wf,	3150.0	9.7	Wf.			
233956 Z CASSIOPEIAE—												
	3133.9<	13.4	Wf,	3141.0	13.3	Wf,	3150.0	13.4	Wf.			
235350 R CASSIOPEIAE—												
	3119.5	11.3	M.									

Total Observations: 1,389. Stars Observed: 237. Observers: 27.

contributions this month, and in particular a slow rising maximum of SS Cygni, 213843, might have escaped notice without the watchfulness of Mr. Waterfield.

Mr. Olcott, the Secretary, has returned from his Mediterranean cruise, and is looking forward to a large attendance at the Spring meeting of the Association, to be held at his home the first Saturday of June. The new observatory, in which he has his glass mounted in a most unique manner for the greatest convenience in variable star work, is to be formally opened, and all those who are planning to come should notify him at 62 Church St., Norwich, Ct., as soon as possible. The E. C. Pickering Memorial Fund is steadily growing, and should be brought to the attention of any who may be interested.

Observers are cautioned again to include full particulars as to size and type of telescope they use.

The following observers contributed to this report: Messrs. Ancarani "An," Bouton "B," Brocchi "Br," Bunch "Bh," Miss Clough "Cg," Ginori "Gi," Godfrey "Gd," Hunter "Hu," Jacobsen "Jb," Kanda "Kd," Lacchini "L," Leavenworth "Lv," Macaughey "Mc," McAteer "M," Mundt "Mu," Paraskevopoulos "Jp," Mrs. Paraskevopoulos "Dp," Peltier "Pt," Proctor "Pc," Reesinck "Rk," Rhorer "Ro," Skaggs "Sg," Suter "Su," Waterfield "Wf," Watson "Pw," Yalden "Ya," and Miss Young "Y."

HOWARD O. EATON, Recording Secretary.

GENERAL NOTES.

The 10-Foot Telescope for the Frye Observatory.—A clipping was sent us this month from the *Seattle Times*, in which it was stated that the great disc of glass, weighing ten tons, for the 10-foot reflector of the Frye Observatory had been successfully cast and annealed and is ready for grinding and polishing. A letter of inquiry to Mr. T. S. H. Shearman, who is directing the work on the mirror, brings the following statement:

"In reply to your letter of the 13th I would say that I shall be pleased to give POPULAR ASTRONOMY particulars from time to time regarding the progress of work on the 10-ft. telescope.

"You will be pleased to know that the speculum will be ready for use in a few weeks. Circular No. 1 of the Frye Observatory will shortly be issued and mailed to you. This will give a full history of the undertaking."

A Gift to the Royal Astronomical Society.—At the meeting of the Royal Astronomical Society (England) April 12,1922, the president, Professor A. S. Eddington, announced a most generous gift of £2500, 5 per cent War Loan, made to the Society by Sir Charles Parsons, K. C. B., F. R. S., to enable it to carry on its work without hindrance in these times of financial stress.

The Astronomische Nachrichten.—This, one of the oldest of astronomical publications, has recently gone through serious crises on account of the heavy expense of printing. It is reported that the Astronomische Gesellschaft has come to the rescue, and that it seems as though the worst difficulties are now past.

Power used in Wireless Transmitting Stations.—M. Henri Deslandres, director of the French Observatory at Meudon, has called attention in a recent address to the progressive increase in horse-power used in the transmitting stations of wireless telegraphy and telephony. When the first French station was etsablished at the Eiffel Tower only three horse-power was used in each signal. In 1910 this was raised to 75, in 1914 to 150, and before the end of the war to 300. When in 1915 a station was constructed at Lyons, in case the Eiffel Tower should be destroyed by the enemy, the transmitting horse-power was 450. In the station erected at Bordeaux it was 1,500. The station now in construction at Ste-Assize, near Melun, has a horse-power of 2,000. In the United States a station is under construction with a horse-power of 10,000. M. Deslandres also stated that the rate of propagation of a wireless wave is one million times faster than that of sound, a signal taking only 1-15th of a second to reach the Antipodes. —(*English Mechanic and World of Science*, May 12, 1922.)

History of the Royal Astronomical Society from 1820 to 1920.—In connection with the centenary of the Royal Astronomical Society, the Council some years ago decided to publish a book giving a short historical account of the work done by the Society during the hundred years of its existence and the conditions under which this work was produced. Owing to financial difficulties the book was not published in 1920, but it will be issued in the course of this year. The period has been divided into seven sections as follow:

1820-1830	written	by	Prof. H. H. Turner.
1830-1840	"	"	Dr. J. L. E. Dreyer.
1840-1850	"	"	Prof. R. A. Sampson.
1850-1860	"	"	Col. E. H. Grove-Hill.
1860-1870	"	"	Prof. H. F. Newall.
1870-1880	"	"	Mr. H. P. Hollis.
1880-1920	"	"	Dr. J. L. E. Dreyer.

The volume will contain about 230 to 250 pages royal 8vo. and will be well illustrated with portraits of Presidents and other leading Fellows of the Society. It is not proposed to print a great number of copies beyond those subscribed for. To subscribers who send their names to the Assistant Secretary before June 15, the price will be 15 shillings, bound, post free. On that day the price will be raised to £1 (postage extra).—(*The Observatory*, May 1922.)

New Telescopes in Construction.—The following interesting information has been obtained in recent correspondence with the Warner and Swasey Company of Cleveland, Ohio.

They have on hand, in the making, some interesting telescopes. They are constructing a mounting for a 60-inch reflector for Professor Perrine, Director of the National Observatory at Cordoba, Argentine. The mounting is of the fork type. It will be located just outside the city of Cordoba in a new observatory to be erected on a slight elevation. The latitude of the new observatory is 31° 40′ south, which will give a splendid view of the southern heavens. When complete, the instrument will weigh about 60,000 lbs. without the optical parts. The tube is of the structural steel type, covered with sheet aluminum. The mounting is designed for observation at both the Newtonian and the Cassegrain foci. It is not adapted for prime focus work. The setting controls and clamping mechanism are to be electrically operated from portable push-button switches. The optical parts are being made at Cordoba under Professor Perrine's direction. It is expected that Professor Perrine will visit the United States during the coming summer.

The Warner and Swasey Company are also making a 12-inch refracting telescope for Cornell University, the mounting of which embodies many improvements and refinements over former telescopes of this size. Among the features is the use of ball bearings both in the polar and declination axes. The main object glass is corrected for photographic work but the tube is to be equipped with a corrector lens to permit visual work. Also amplifying attachments are to be provided for amplification to five and ten when used photographically. The main object glass was ground and figured some two years ago by Mr. J. B. McDowell of Pittsburgh. The instrument is to be installed in a new observatory at Ithaca which is being prepared to receive the mounting in June of this year. It is expected that a double slide plate holder and also a spectrograph will later be added to the equipment.

The same firm has in preparation preliminary plans and specifications for a large reflector for one of our prominent universities.

All astronomers will also be pleased to learn that at the last annual meeting of the National Academy of Sciences, Mr. Ambrose Swasey was elected a member of the Academy in the newly organized section of Mechanical Engineers.

E. E. B.

An Interesting Quadruple Star.—The star ι Trianguli is a visual double whose components have a separation of 3″.5. The magnitude is about 5. In the

Journal of the Royal Astronomical Society of Canada for April, W. E. Harper, of the Dominion Astrophysical Observatory at Victoria, B. C., announces that both visual components are spectroscopic binaries, the brighter with a period of 14.7 days and the fainter with a period of 2.2 days. The period of the visual double is not known but it appears to be of the order of 2000 years. We thus have another of the interesting quadruple systems like Castor.

The Distances of the Globular Clusters.—Within the last few years a great deal of attention has been given to the determination of the dimensions of the stellar system. Shapley's work at Mt. Wilson led him to results increasing these dimensions to about ten times those assumed before. One of the lines of reasoning used by him was the apparent connection between the period of variation of stars of the δ Cephei type and their absolute magnitude (The absolute magnitude is usually defined as the apparent brightness of the star if placed at a distance of 10 parsecs or 33 light years). This connection appears to be that the more rapid the variation the fainter the star. If fully established and the distance of one of the stars could be determined then the distance of any star of this class would be determined as soon as we know its period and apparent brightness. In the globular clusters there are many variable stars of the δ Cephei type and Shapley, using the connection between period and luminosity, derived distances for the globular clusters ranging from about 20,000 to 200,000 light-years. In order to test the validity of the period-luminosity law which Shapley used Kapteyn and van Rhijn made a determination of the distances of the δ Cephei variables whose period is shorter than 2/3 day from the proper motions determined from plates of the astrographic program taken at Algiers and Potsdam. The intervals available between plates of the same regions averaged about 25 years. The results just published in *Bulletin of the Astron. Institutes of the Netherlands*, No. 8, place these stars at about 13 percent of the distance used by Shapley. Accordingly the distance of the globular clusters would be about 1/8 of the distance obtained by Shapley and thereby reduce the probable dimensions of the galactic system to the old estimates. As time goes on and additional observations are obtained it will be interesting to see if the old or the new dimensions will prove to be the true values.

Annals of the Astronomical Observatory of Moscow, Vol.VI, 1917, has been received recently. It contains photometric observations of various stars made by the director, Prof. W. Ceraski. The disturbed conditions in Russia no doubt prevented an earlier distribution. We hope that the situation in Russia will improve so that Prof. Ceraski may continue his valuable work.

The Globular Cluster Messier 3.—Prof. F. Küstner, director of the observatory at Bonn, has just issued results of his measures of nearly 1000 stars of this cluster in *Veröffentlichungen der Universitäts-Sternwarte zu Bonn*, No. 17. These exactly determined positions of the brighter stars of the cluster down to about magnitude 16 will be of great value in future years for the determination of the relative motions of the cluster stars.

A Spectroscopic Study of Early Class B Stars.—Dr. F. Henroteau's third paper on these interesting stars has just been issued as No. 8 of Vol V, *Publications of the Dominion Observatory, Ottawa.* The results for 31 stars are

contained in this paper. A number of these stars were previously known to be spectroscopic binaries and the paper gives evidence which will place others in the same class.

Materials on the Surfaces of the Moon,—In No. 77 of the *Publikationen des Astrophysikalischen Observatoriums zu Potsdam* Prof. J. Wilsing reports on observations made by himself and the late Prof. J. Scheiner with a spectralphotometer on certain regions of the moon and on various rock specimens. While this comparison was not altogether satisfactory yet one point of interest may be mentioned. The dark regions of the moon have about the albedo of the darkest terrestrial lavas and obsidians while the lightest regions have the albedo of quartz porphyry and granite.

The last section of the publication is devoted to a consideration of the formation of the surface features of the moon. It is assumed that the moon was a hot fluid mass during its early history and the author accepts with little reservation the volcanic theory of the origin of the surface features.

Radium Star Maps.—We have received from Mr. E. W. Sundell, 225 N. Grove Ave., Oak Park, Ill., two copies of his radium star map. On one of these both stars and constellation figures are marked in radium paint and on the other the stars only. We have used both maps with a class in studying the constellations with great success. The class members were enthusiastic over the new maps and voted unanimously that the radium map is a great advance over the ordinary kind in that it can be held up against the sky and compared with it directly, thus eliminating the use of any other source of light. The new map can be highly recommended as an aid in constellation study.

A Woman Astronomer in the Hall of Fame.—On Saturday, May 20, 1922, at the Hall of Fame connected with the New York University, there were unveiled five busts of famous Americans. Of the five, one was that of Maria Mitchell, the astronomer. She was also the first woman to be thus honored. The presentation address was given by President Henry M. MacCracken of Vassar College, where Miss Mitchell was Professor of Astronomy for many years.

New Members of the American Academy.—At the recent annual meeting of the American Academy of Arts and Sciences Prof. A. S. Eddington of Cambridge, England, was elected a foreign honorary member and Prof. W. S. Adams of the Mt. Wilson Observatory a fellow.—(*Science*, May 26, 1922.)

POPULAR ASTRONOMY

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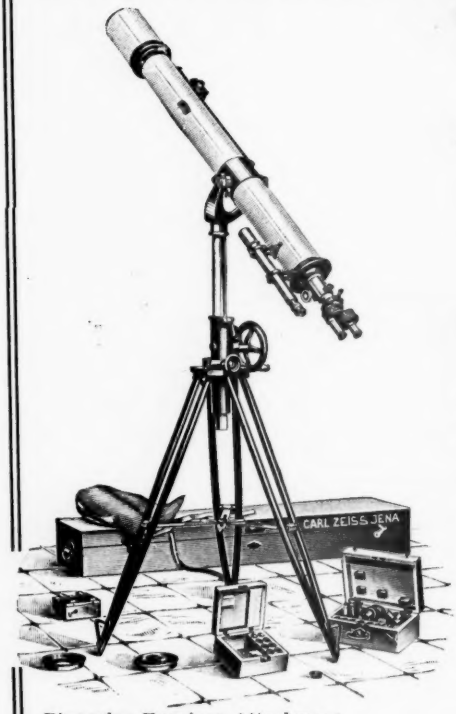

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